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IS MENTAL RESEMBLANCE RELATED TO PHYSICAL RESEMBLANCE IN SIBLING PAIRS?*[1]

From the Psychological Laboratories of Stanford University

BARBARA S. BURKS AND RUTH SHERMAN TOLMAN

The conception that mental processes are closely related to physical structures, particularly of the central nervous system, is necessary unless we wish to imagine ourselves as completely dualistic beings in which mind and body pursue independent paths that meet only by coincidence. Although most experimental attempts to establish the presence of correlations between normal variations in mental and structural traits have failed, the results far from disprove that close interdependence exists. They only demonstrate that the problem is a resistant one, and that associations have not yet been sought in the domains where they actually reside

Phrenology and various other "systems" of character analysis are the outlawed progeny of dignified speculations that began in the armchairs of philosophers, and continued in the modern laboratories of psychologists If logical grounds alone do not answer the bizarre claims of these "systems," such experiments as those of Paterson and Ludgate (10), Kenagy (7), Cleeton and Knight (1), Sheldon (12, 13), and Hull and Evans (5) do so most adequately These investigators have reported zero correlations between reliable pooled ratings of personality traits and the features of head and face on which various "systems" pin their faith.

Pronounced relationships between anatomical structures and mental and personality characteristics will probably never be found as long as they are sought with utter disregard of the intrinsic functions of physical organs. To expect generosity with a wide mouth, or a calculating disposition with small ears, is as reasonable as to look for the cause of color-blindness in the alimentary canal While the work

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[1]The writers gratefully acknowledge the cooperation of Superintendent Sexson of the Pasadena City Schools, of Miss Margaret Bennett, Supervisor of Guidance, and of the many principals, counsellors, and teachers who assisted in numerous ways They also wish to thank Professor Lewis M Terman for his constructive interest and counsel

of Kretschmer upon morphological types might seem to offer an instance of correlation between traits having no intrinsic connection, the explanation of his results probably lies in the endocrine secretions that affect temperamental as well as morphological patterns.

It is not unlikely, however, that genetic linkages may be discovered within family groups between disparate human traits whose only bond in common is the chromosome in which their determiners lie. Many such linkages have been found between unit characters in the lower animal forms, especially in *Drosophila*. With the exception of "sex-linked" characters such as hemophelia or color-blindness, however, no clear case of simple linkage has yet been reported in man Since there are only a few human traits which behave as unit characters, one's best chance of discovering linkages is probably to examine variable traits determined by several or many genes.

Problem of Present Study

The present study investigates the possibility that some of the genes for mental ability and general physical appearance are linked. There is a widespread impression that this is the case. In lay circles in which the principles of genetic inheritance are unknown, the comment is frequently made that this child "takes after" his father's side of the house, that another child is "exactly like his mother's people," while still another "is just his older brother all over again." The family commonly expects these children to grow up with the mental and personality traits of the relatives they most resemble in appearance, and is fearful if a child in its midst looks too much like some unfortunate black sheep whose portrait has been turned to the wall

There is a sound theoretical reason why the amount of physical resemblance which a child bears to his father or to his mother should not influence in the least the amount of his resemblance to either parent in hereditary mental traits. Each parent always contributes half of the 48 chromosomes which determine within more or less narrow limits the course of a child's mental and physical development If the child happens to inherit, for example, the brown eyes of one of his parents, this does not mean that the child has received a "larger share" of heredity from the parent in question. The other parent has also contributed a chromosome in which is located a gene for eye color—possibly for blue. As brown happens to be a

dominant color, this blue-eye gene is temporarily lost to view, only to reappear later among some of the child's descendents in the absence of genes for a dominant color. If some mental trait, such as musical ability, should happen to have one of its genes located in the same chromosome, it does not follow that the parent whose gene for eye-color was dominant over that of the other parent should show a similar dominance for musicality. On the contrary, it is a matter of pure chance which parent, if either, should do so. Many genes, like those for color in the blue Andalusian fowl, do not exhibit the phenomenon of dominance to any appreciable extent, but display, instead, a blending effect when combined

In the case of siblings, the situation is altered Though each sibling receives a full set of 48 chromosomes (24 from each parent), it is a matter of chance which 24 of the 48 chromosomes per parent will fall to his lot On the average, a pair of siblings, unless they are duplicate twins, share only half their chromosomes in common, but the number of shared chromosomes may vary, according to the law of normal probability, from 48 to zero When the number of shared chromosomes is less than 6, the relationship of siblings, genetically speaking, is less close than that of ordinary first cousins.

It is reasonable to suppose that siblings who resemble one another very closely in physical appearance have received an unusually large chance number of chromosomes in common, and that siblings who impress an observer as showing little or no family resemblance have an unusually small overlapping of chromosomes. If the particular chromosomes involved in the traits under scrutiny should happen also to contain genes for certain mental traits, we might expect the siblings who looked most alike to be the most alike psychologically, and those who looked least alike to show unusually large mental differences.

Nomination of Cases

In the investigation, which was carried out in Pasadena, every public school was provided with nomination blanks upon which to note the names of pairs of brothers and pairs of sisters who resembled one another unusually much or unusually little in general appearance. Teachers and others who filled out the blanks were not told that the study would later be concerned with the mental traits of these children, for we wished to avoid as far as possible any bias of

selection that might distort results. We asked simply for the names of pairs (not twins) "who look so much alike that a person acquainted with one child but not with the second would, on meeting the second, instantly recognize him as belonging to the same family as the first," and of pairs "who are so different in appearance that a stranger would scarcely believe they belonged to the same family."

All siblings nominated from the junior-high-school and senior-high-school grades (7 to 12) were rated for general resemblance on a 9-point scale independently by the two writers. In addition to siblings nominated from the elementary schools, *all* like-sex sibling pairs attending two representative elementary schools were seen and independently rated. The latter group, consisting of 141 pairs, was used for computing the reliability of the ratings, and for determining the proportions of random sibling pairs which display physical resemblance of varying degrees. In this group, as in the group of nominated pairs, children meeting certain criteria to be described were selected for further study.

In order to simplify interpretation, only white English-speaking children of north-European or mixed "American" descent were included in the statistical treatment which follows. Half-siblings were, of course, excluded. It is believed that the results are free from selective influences other than those always attendant upon studies of siblings taken from a school population, and that the correlations can, therefore, be fairly compared with those reported by other investigators.

The Ratings

The following scale was used by the writers in making their ratings:

1. Almost as much alike in general appearance as identical twins
2. Very marked family resemblance
3. Marked family resemblance
4. Slight family resemblance
5. No noticeable resemblance
6. Slight difference in type
7. Marked difference in type
8. Very marked difference in type
9. As different as two people of the same race could be

The writers carefully agreed upon the significance which they would assign to the scale, and made several practice ratings before beginning their field work. Their independent ratings of (1) the siblings nominated from the junior and senior high schools, (2) the siblings nominated from the elementary schools, and (3) all like-sex sibling pairs attending two elementary schools [including some from (2)] gave the following correlations:

	r	PE_r	N
1	71	04	80
2	75	04	67
3	67	03	141

The fact that correlations 1 and 2 are slightly higher than the third is due to the presence of a larger number of extremely similar or dissimilar pairs among the nominated cases than among the random cases. If correlation 3 is corrected by the Spearman-Brown formula to give the reliability of the average of two ratings in an unselected group, the result is 80

Average ratings were distributed in the group of 141 unselected sibling pairs as in Table 1.

Collection of Data

The original plan of the experimenters was to administer the Stanford-Binet test to the like-appearing siblings of the elementary schools

TABLE 1
Resemblance Ratings of Unselected Sibling Pairs

Rating interval	Boys	Girls	Total	Percentage reaching or exceeding
1 5-1.99		3	3	2 1
2 0-2 49	4	4	8	7 8
2.5-2.99	5	10	15	18 4
3 0-3 49	15	14	29	39 0
3 5-3 99	23	18	41	68.0
4 0-4 49	15	5	20	82 2
4 5-4 99	5	4	9	88 6
5 0-5 49	4	2	6	92 8
5 5-5 99	3	1	4	95 7
6 0-6 49	1	2	3	97 8
6 5-6 99		1	1	98 5
7 0-7 49		1	1	99 3
7 5-7 99	1		1	100 0

TABLE 2*

RESEMBLANCE RATINGS OF ELEMENTARY SCHOOL LIKE-APPEARING PAIRS

Average rating	Percentage of unselected siblings reaching or exceeding	Number of pairs tested
2.0 or higher	3.5	17
2.25	7.8	6
2.5	15.6	11
		34

*The sisters in one of the 34 pairs were attending a junior high school, but as both children were under 14 years of age they were given the Stanford-Binet as well as the Terman Group Test

whose average rating of resemblance was 2.0 or better. Only 3.5% of the unselected siblings received so high a rating As this boundary netted only 17 cases, it was extended to include siblings whose average ratings were distributed as in Table 2. The 34 cases of Table 2 include 11 pairs of brothers and 23 pairs of sisters. In 24 pairs the older child was tested by the junior author and the younger child by the senior author, in 2 cases Miss Natalie Raymond and the senior author each tested one member of a pair, and in 8 cases the senior author tested both members of each pair.

Limitations of time prevented the testing of a comparable group of elementary-school unlike-appearing sibling pairs. Four pairs of brothers whose average ratings ranged from 5 to 7 were tested, however, with interesting results.

Terman Group Test scores were obtained for all sibling pairs nominated and rated at the junior and senior high schools The distribution of average ratings of resemblance in these pairs is shown in Table 3. In approximately 60% of the cases the Terman Group Test was administered by the writers. Scores upon this test were obtained for the remaining cases from the school files. The ratings were made before the tests were scored or obtained from the files, and nearly all the tests were scored by a third person who was unfamiliar with the ratings. Four pairs are included in Table 3 who were rated by only one of the experimenters.

Tables 1, 2, and 3 all indicate that the standards employed by the writers in rating the girls were somewhat more lenient than those used in rating the boys, for more girls than boys received high ratings.

TABLE 3

RESEMBLANCE RATINGS OF JUNIOR- AND SENIOR-HIGH-SCHOOL NOMINATED PAIRS

Rating interval	Boys	Girls	Total
1.5-1.99		1	1
2.0-2.49		2	2
2.5-2.99	1	3	4
3.0-3.49	4	6	10
3.5-3.99	12	11	23
4.0-4.49	5	9	14
4.5-4.99	4	6	10
5.0-5.49	2	5	7
5.5-5.99	2		2
6.0-6.49	1	4	5
6.5-6.99	2	1	3
7.0-7.49	3		3
	36	48	84

TREATMENT OF DATA

1. In the group of 34 elementary-school like-appearing siblings the IQ of the older member of each pair was correlated against the IQ of the younger member.

2. In the junior- and senior-high-school group of 84 pairs, the following subdivisions were made:

a. 20 like-appearing pairs whose ages were less than 15-0 (rating 3.5 or better)

b. 23 unlike-appearing pairs whose ages were less than 15-0 (rating less than 3.5)

c. 32 like-appearing pairs of all ages, including those of (*a*) (rating 3.5 or better)

d. 52 unlike-appearing pairs of all ages, including those of (*b*) (rating less than 3.5)

e. 20 cases with highest rating of resemblance, regardless of age (rating 3.5 or better)

f. 20 cases with lowest ratings of resemblance, regardless of age (rating 5.0 or less)

Terman Group Test IQ's were computed for Groups *a* and *b* in the usual way. In Groups *c* and *d* certain empirical assumptions were made, viz., that the average IQ of the children in age groups above 14 was equal to that of the children of lesser age, and that it took the same number of points on the test to equal one point of IQ

TABLE 4
CORRELATIONS BETWEEN IQ'S OF LIKE- AND UNLIKE-APPEARING PAIRS

	r	PE_r	N
Group 1, elementary school, likes	.45	.09	34
Group 2, junior and senior high school			
a. Likes under 15-0	.78	.06	20
b. Unlikes under 15-0	.31	.13	23
c. Likes of all ages	.67	.07	32
d. Unlikes of all ages	.61	.06	52
e. Pairs most like	.61	.09	20
f. Pairs most unlike	.63	.09	20

among children above 14 as it did among children of 14. These assumptions are probably only approximately accurate, but give "estimated" IQ's whose values are more reasonable than those yielded by a MA/CA ratio in children over 14. As in the case of Group 1, the IQ of the older child was correlated against that of the younger child of each pair.

RESULTS

Table 4 summarizes the correlation coefficients between the IQ's of the sibling groups just described.

The IQ's of the children in Groups 1 and 2 had means and standard deviations as shown in Table 5, in which the mean chronological ages are also listed.

With the exception of correlations *a* and *b* for Group 2, the correlations reported in Table 4 are fully in accord with those found by other investigators for groups of siblings of similar grade range measured upon tests similar to those used in this study. Upon indi-

TABLE 5
MEASURES OF CENTRAL TENDENCY AND DISPERSION OF IQ'S

	Mean IQ	SD	Mean CA	N
Group 1 (likes)				
Older of pair	101	14	9-9	34
Younger of pair	106	12	7-5	34
Group 2 (likes)				
Older of pair	101	15	11-4	32
Younger of pair	107	14	12-8	32
Group 2 (unlikes)				
Older of pair	101	12	11-9	52
Younger of pair	106	14	13-1	52

vidual tests (chiefly the Stanford-Binet), various investigators have reported sibling correlations as follows:

Rensch (11) (1921)	.45
Elderton (2) (1922)	
using Gordon's data	.54
using Drinkwater's data	.38 to .53
Hart (3) (1924)	.40 to .46
Madsen (8) (1924)	.63
Hildreth (4) (1925)	.41
Jones (6) (1928)	.49

Thorndike (15) has reported correlations of .66 and .73 between I.E.R. group test scores (interpreted in terms of age norms) of siblings attending high schools.

Since correlations *a* and *b* for Group 2 (Table 4) are based upon only a small number of cases, and are not checked by any of our other correlations, we are not justified in attributing significance to the difference between them. Correlations *c* and *d*, based upon larger numbers, display a difference that is insignificant in the light of its probable error. In correlations *e* and *f*, what slight difference occurs is in favor of the unlike group! The correlation, .45, between the like pairs of Group 1 is certainly no higher than would be expected on the basis of previous work with siblings tested on the Stanford-Binet. In this connection, it is interesting to compare the differences found between the Stanford-Binet IQ's of four pairs of very unlike-appearing brothers. The average IQ difference for the four pairs was 9.5 as against 13.4 for the 34 like pairs, and 12.0 for a group of siblings differing less than two years in age who were studied by Tallman (14). The present study, then, offers no evidence in support of linkage between intelligence and general physical appearance of siblings.

It is possible that the siblings considered in this study were not selected rigorously enough to show linkage if it exists. To gain a little light on this possibility, we examined the records of four pairs of siblings who resembled one another so closely in appearance that only their differences in size served to distinguish them for the casual observer. The IQ's of these pairs were as follows:

1. Brothers of 10 and 7, IQ's 103 and 105.
2. Sisters of 11 and 10, IQ's 92 and 91.
3. Sisters of 11 and 8, IQ's 128 and 95.
4. Sisters of 7 and 5, IQ's 87 and 116.

Two pairs were very similar in IQ, but the other two pairs showed differences in IQ that were exceeded by only one other pair of Group 1.

Finger prints were taken by the writers for Cases 1, 2, and 4, but not for Case 3 because of the illness of one of this pair. The patterns are indicated below. The friction ridge patterns of duplicate

	Left digits					Right digits				
	1	2	3	4	5	1	2	3	4	5
Case 1										
Oldest	W	L.P.	L.P.	W.	L.P	U	L.P.	L.P	W.	U.
Youngest	U.	R	T.A	U.	U	U	T.A.	U.	U	U
Case 2										
Oldest	U	T.A	U.	U.	U	U.	T.A	U	U	U
Youngest	U.	T.A	U.	U	U.	U	U	U	U.	U
Case 4										
Oldest	U.	U.	U	U	U	U.	R	U.	U	U.
Youngest	U.	U.	U	U.	T.A	U.	A.	T.A	U	U

twins have proved to be so amazingly similar that Newman and others use them for one of the chief criteria in distinguishing between fraternal and duplicate twins. The writers believed that friction ridge patterns might be of great assistance in determining the amount of overlapping in sibling inheritance.

In Case 1, which is really the most striking case of physical resemblance among all the pairs studied, only two pairs of corresponding fingers have the same patterns. Yet the IQ's of these brothers differ by only two points. In Case 2 there is a high degree of correspondence between the finger patterns of the two sisters, and also a close correspondence in their IQ's (difference of only one point). But the fact that most of the patterns are ulnar loops deprives this comparison of some of its significance, since the ulnar loop has the highest incidence of all patterns in the general population. In Case 4, which shows the large difference of 29 points of IQ, seven of the ten pairs of fingers have the same pattern (though all seven are ulnar loops). While it is possible that palm patterns, which were not taken, would have yielded results of positive significance, the finger-print comparisons seem to furnish no explanation of the mental resemblance of Cases 1 and 2, nor of the disparity of Case 4.

Summary

The study investigates the possibility that some of the genes in-

volved in mental ability and general physical appearances are linked A rating scale of physical resemblance was devised for use in selecting cases for mental tests The average of two ratings on general resemblance had a reliability of .80 in a group of 141 white, English-speaking, like-sex sibling pairs attending elementary schools

Intelligence tests were administered to a group of 34 elementary school sibling pairs showing strong physical resemblance, and to 84 pairs of junior-high-school and high-school sibling pairs sub-divided into groups showing much and little physical resemblance The resulting correlations do not support the view that siblings who look most alike are most alike psychologically, or that those who look least alike show unusually large mental differences.

Of four elementary school pairs whose physical resemblance was extremely close (within the top two per cent of random pairs), two pairs were very similar in IQ, but two pairs showed differences in IQ that were exceeded by only one other pair of the elementary school series Finger-print comparisons obtained in three of these four cases failed to shed light on the causes of IQ resemblance and disparity.

References

1. Cleeton, G V, & Knight, F B Validity of character judgments based on external criteria *J Appl. Psychol.*, 1924, **8**, 215-231
2. Elderton, E. M A summary of the present position with regard to the inheritance of intelligence *Biometrika*, 1922, **14**, 378-408.
3. Hart, H Correlations between intelligence quotients of siblings *School & Soc.*, 1924, **20**, 382
4. Hildreth, G The resemblance of siblings in intelligence and achievement *Teach. Coll. Contrib Educ*, 1925, No 186 Pp 65.
5. Hull, C. L Aptitude testing Yonkers, N Y : World Book Co., 1928 Pp xvi+535
6. Jones, H E A first study of parent-child resemblance in intelligence *27th Yrbk Nat Soc Stud Educ.*, 1928, Pt 1, 61-72
7. Kenagy, H G Do blonds make the best salesmen? *Sales Management*, 1923, 325-328
8. Madsen, I N Some results with the Stanford Revision of the Binet-Simon tests *School & Soc*, 1924, **19**, 559-562.
9. Newman, H. H Studies of human twins I. Methods of diagnosing monozygotic and dizygotic twins *Biol Bull*, 1928, **55**, 283-297
10. Paterson, D G, & Ludgate, K. E Blond and brunette traits a quantitative study *J. Person. Res*, 1922, **1**, 122-127.
11. Rensch, G E A study of 365 pairs of siblings with reference to the influence of heredity on mental ability M.A thesis, Stanford Univ, 1921 Pp. 35

12. SHELDON, W. H. Ability and facial measurements. *Person. J.*, 1927, 6, 102-112.
13. ———. Social traits and morphological types. *Person. J.*, 1927, 6, 47-55.
14. TALLMAN, G. G. A comparative study of identical and non-identical twins with respect to intelligence resemblances. *27th Yrbk. Nat. Soc. Stud. Educ.*, 1928, Pt. 1, 83-86.
15. THORNDIKE, E. L. The resemblance of siblings in intelligence. *27th Yrbk. Nat. Soc. Stud. Educ.*, 1928, Pt. 1, 41-53.

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LA RESSEMBLANCE MENTALE A-T-ELLE RAPPORT À LA RESSEMBLANCE PHYSIQUE CHEZ LES PAIRES D'ENFANTS DE MÊME FAMILLE?

(Résumé)

Il s'agit dans cette étude de la possibilité que quelques-uns des facteurs compris dans la capacité mentale et l'apparence physique générale ont rapport les uns aux autres. On a fait une échelle d'évaluation à employer dans le choix des enfants de même famille auxquels on fait subir des tests mentaux. La moyenne de deux évaluations de la ressemblance générale a eu une constance de 0,80 chez un groupe de 141 paires d'enfants de même famille, de race blanche, de même sexe, de langue anglaise, assistant à des écoles élémentaires.

On a fait subir des tests d'intelligence à un groupe de 34 paires d'enfants de même famille montrant une grande ressemblance physique, élèves d'une école élémentaire, et à 84 paires d'enfants de même famille, élèves des écoles "Junior and Senior High," subdivisés en groupes montrant beaucoup et peu de ressemblance physique. Les corrélations qui en résultent ne soutiennent pas la théorie que les enfants de même famille de la plus grande ressemblance physique se ressemblent le plus psychologiquement, ni que ceux montrant la plus grande différence d'apparence physique montrent de très grandes différences mentales. Les corrélations entre les Q.I. des enfants de même famille, y compris ceux qui se ressemblent et ceux qui ne se ressemblent pas, n'ont différé que d'une façon insignifiante des corrélations rapportées par les investigateurs antérieurs pour les enfants de même famille non choisis.

Parmi quatre paires des élèves de l'école élémentaire d'une très grande ressemblance physique (dans les deux pour cent supérieurs des diverses paires), deux paires se sont beaucoup ressemblées en Q. I., mais deux paires ont montré des différences du Q.I. dépassées seulement par une autre paire de la série de l'école élémentaire. Des comparaisons des impressions des doigts obtenues dans trois de ces quatre cas ont manqué de montrer les causes de la ressemblance et du manque de ressemblance des Q.I.

BURKS ET TOLMAN

GIBT ES EINEN ZUSAMMENHANG ZWISCHEN KÖRPERLICHER UND GEISTIGER AHNLICHKEIT BEI GESCHWISTERPAAREN?

(Referat)

Die Verfasser untersuchten die Moglichkeit, dass einige der Genen, die mit geistiger Fahigkeit einerseits und mit allgemeiner korperlicher Ahnlichkeit anderseits in Zusammenhang stehen, mit einander verbunden (linked) sind Es wird eine Massleiter (rating scale) zur Messung der korperlichen Ahnlichkeit erfunden, zum Gebrauch bei der Wahl von Geschwistern, an denen man dann Geistesprufungen machen wollte Der Durchschnitt zweier Messungen allgemeiner Ahnlichkeit zeigten eine Zuverlassigkeit (reliability) von 80 bei einer Gruppe bestehend aus 141 weissen volksschulpflichtigen (elementary school) Englischsprechenden Geschwisterpaaren gleichen Geschlechts

Es wurden Intelligenzprufungen gemacht an 34 volksschulpflichtigen Geschwisterpaaren die starke korperliche Ahnlichkeiten zeigten und an 84 Geschwisterpaaren aus Unter-und-Ober-realschulklassen (junior and senior high school), geteilt in zwei Gruppen von denen die eine viel, die andere wenig korperliche Ahnlichkeit zwischen den Geschwistern zeigte Die erfolgenden Korrelationen unterstutzten nicht die Ansicht, dass Geschwister die sich korperlich am meisten gleichen sich auch psychologisch am meisten ahneln, oder das diejenigen, die sich korperlich am wenigsten gleichen auch geistig ungewohnlich stark von einander abweichen Die Korrelationen zwischen den Intelligenzquotienten von sich-gleichenden wie von ungleichen Geschwistern zeigten keine bedeutungsvolle Abweichungen von Korrelationen welche durch fruhere Untersucher an nicht-ausgelesenen Kindern ermittelt wurden

Unter vier volksschulpflichtigen Geschwisterpaaren bei denen die korperliche Ahnlichkeit ungemein stark war (sie gehorten in dieser Beziehung dem obersten zwei Prozent der unausgelesenen Paare an), waren bei Paaren die Intelligenzquotienten sehr ahnlich. Bei den zwei anderen Paaren, aber, zeigten sich in den Intelligenzquotienten Unterschiede welche nur von einem einzigen Paar in der Volksschuleserie uberschritten wurden. Die Grunde der Ähnlichkeit oder Verschiedenheit der Intelligenzquotienten wurden durch Vergleichungen der Fingerabdrucke, an drei der vier Paare erhalten, nicht erhellt.

Burks und Tolman

THE GROWTH AND SIGNIFICANCE OF DAILY VARIATIONS IN INFANT BEHAVIOR*

From the Clinic of Child Development of Yale University

HELEN THOMPSON

It has been repeatedly shown in the Clinic of Child Development Laboratory at Yale that in the first year of life monthly growth changes in behavior are definitely measurable. We have seen no infant, excluding definitely defective cases, in whose behavior there was no evidence of an increment at the end of a four-week interval. The questions naturally arise: What is the smallest interval of time after which growth is discernible? And what is the nature of the growth increment? During the course of an experiment undertaken to answer other questions, daily records of an infant's responses during a defined and controlled period of the day were obtained. The study of these data not only offers a temporary answer to the above questions, but furnishes suggestions concerning the scaling and measurement of infant behavior.

The original experiment is reported in a *Genetic Psychology Monograph* (2), by Dr. Arnold Gesell and the author. The details concerning the experiment, the set-up, the history of the subject and the control subject will not be represented but are available for reference in the above-cited monograph. Only the essential facts for this report will be repeated.

The subject, Twin *T*, was one of a pair of identical girl twins, 46 weeks old at the beginning of the experiment. Twelve developmental quotients, determined between the ages of 24 and 79 weeks, range from approximately 75 to 85. She is therefore developing more slowly than the average infant. During the experimental period her health, with the possible exception of one day, was apparently good. Chart 1 gives her temperature and weight growth during this period.

The experiment was conducted in a special examining room of the Nursery Home in which the twins resided. Daily, except Sundays, for 10 minutes, starting at nine o'clock, the subject was placed in the

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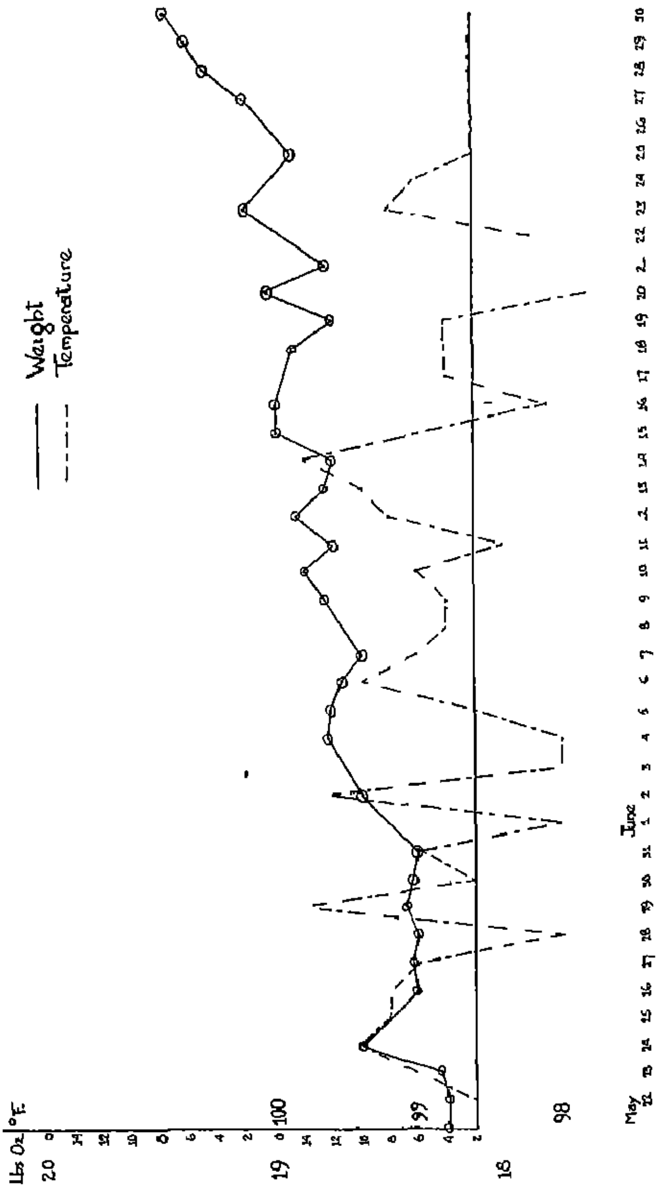

CHART 1

Temperature and Weight Chart of Twin T

experimental crib (1) fitted with a board resting on the side panels which were raised about 7 inches. On this table top, prearranged, were 10 red cubes, one inch square, massed in regular formation: 9 cubes forming a square as a base and the 10th one placed on the middle cube. As stated in the monograph, "When the infant did not spontaneously play with the cubes, her activity was stimulated by the Examiner as follows: (1) E handed the cubes to T one by one (2) E built a tower of blocks, within T's reach; (3) E took a cube from T and immediately re-presented it, repeating the process in a playful manner to make it a game, (4) E held out her hand for a cube and said, 'Give it to me'; (5) by gesture and demonstration, E made repeated efforts to have T hit two cubes together, in a pat-a-cake manner" Occasionally when she disregarded the cubes, turning to gross motor activity, another aspect of the experiment not discussed here (training in gross motor activity) was undertaken for 10 minutes and then the cube play was again begun. The total duration of the cube play observation was always 10 minutes as indicated by a stop-watch. The experiment was continued for 40 days. On the 28th day after the beginning of the experiment, a red box was presented with the cubes; this was necessary because the cubes were beginning to lose their motivating value. The behavior on days subsequent to the introduction of the red box has not been compared with that on days before the box was included but has been compared only with the other days in the later period.

The co-twin, Twin C, was the control subject. At the beginning of the experiment, at the end of two weeks, and at the end of the experiment, Twin T and Twin C were compared in test situations. The test period for cube play was only approximately 5 minutes whereas the regular daily observation was 10 minutes in length. Therefore, the test-period behavior is not as diverse as the daily behavior, infrequent behavior did not occur in the shorter period. The test situations for both infants were, however, highly similar During the experiment, both the observer's activity and the infant's behavior were concurrently dictated to a stenographer seated in an inconspicuous corner of the room. These dictated records are the data which have been studied for evidence of changing behavior patterns The record for the first day was read; items of behavior were abstracted and arranged vertically in order of their appearance Checks in the first opposite column indicated the items appearing on the first day The record for the second day was read, new items of behavior were added

to the original list and all items occurring on the second day were checked in the second column. This procedure was continued for the records for the total experiment. Items describing already fully developed abilities and therefore not significant at this stage of development were omitted. Chart 2 was the result. The underlined checks on the 1st, 14th, and 42nd day after the beginning of the experiment mark the control subject's behavior. The items, for convenient reference, are numbered at the left, those appearing on the same day have been designated by the same number followed by a differentiating letter.

The writer is duly conscious of the subjective errors which may be involved in the following analysis. In the first place, the records are mere observations. However, the observer had had a year-and-a-half's experience in observing and dictating, almost daily, cube play of infants. She was, therefore, alert to the child's activity from the beginning; it can be said with confidence that new items which appear are not due to her increased skill in observation. Neither can they be due merely to the infant's growing adjustment to the cubes, crib, room, and Examiner: the control twin gives ample evidence for that. Another danger is that we will read into the items a significance not there. But it has been our experience that we are more likely to do just the opposite—to fail to see the relation between early and subsequent behavior which close and prolonged study reveals.

The play was stimulated by the observer. Unevenness of stimulation could be a factor. Tests on the control twin indicate that this stimulation had little effect on the actual performance, except in the social aspect of growth. It is not possible to stimulate behavior beyond the maturational level (2). Therefore, it is not likely that any changes in performance are due to the observer's instigation. If they had been, and if the incitement had been uneven, a more fluctuating picture than is presented would have been the result.

A number of the items have been studied in the normative investigation now in progress at the Yale Clinic of Child Development. In the normative examination, the multiple-cube situation lasts about 3 minutes while the daily periods of this study were 10 minutes. Although, therefore, a direct comparison is not possible, the change in the frequency of infants displaying behavior at the consecutive lunar monthly age levels indicates the maturity value of the behavior and reference will be made to this as yet unpublished material whenever it is pertinent.

No. days after beginning experiment ⟶

Date ⟶

Age of subject in weeks ⟶

Items:

								1-a	Secures one cube
								-b	Accepts second cube, retaining first
							a	-c	Resecures cube as soon as dropped
			c			b		-d	Hits cube against cube on table top
1-2			c				a	2-a	Tips cube with index finger, holding cube in hand
1-2	s							-b	Extends cube to Examiner
1-2								3-a	Hits cube against table top imitatively
1-	s							-b	Vocalizes when cubes are removed
1-2		l				b		4-a	Hits cube against crib platform
1-				p				-b	Vocalizes during play activity
1-							a	-c	Secures two cubes in one hand
1-			c	p				-d	Hits cubes together, pat-a-cake fashion
1-			c	p				-e	Hits cube about on table top, using cube in hand
1-2		l				b		5-a	Carries cube from table top to crib platform
1-2	s							-b	Vocalizes when talked to
1-2			c		r		a	6-a	Releases one cube over another
1-2		l				b		-b	Hits cube against crib side rail
1-2	s				r			-c	Releases cube to Examiner
1-2				p				7	Scatters cubes, brushing with hands
1-2		l						8-a	Creeps with cube in hand
1-2				p	r			-b	Lifts cube high and drops it
1-2				p				-c	Rubs hands back and forth on table top
1-2					r	b		9	Drops cube to floor over crib side rail
1-2						b		10-a	Hits cube against wall
1-			c	p				-b	Hits cube to platform with cube in hand
1-2				p	r			11-a	Throws cube on table top
1-				p				-b	Rubs cube back and forth on table top
1-2					r			12	Drops one cube to take another
1-2							a	13-a	Secures cube between index fingers
1-				p				-b	Scratches cube with index finger
1-2							a	14-a	Holding two cubes, attempts to store one cube and secure third
1-2							a	-b	Holds third cube between two, one in each hand
1-2					r			15-a	Releases cube in box
1-		l			r			-b	Releases cube on shoe
1-2				p				16	Cruises with cubes
1-2				p				17	Pokes cube, using index finger
1-2				p	r			18	Opens hand, lets cube roll out
1-2				p	r			19-a	Casts cubes about vigorously
1-2		l						-b	Insists on standing for cube play
1-2			c		r			20	Places cube on cube, releasing cube in hand
1-			c	p				21	Taps one cube on top of another

Laughs or squeals

Plays lazily

Frets

CHART 2

s—social
l—locomotor
c—cube-combining play
p—explotive play
r—releasing ability
b—broadening activity
a—acquisitive ability

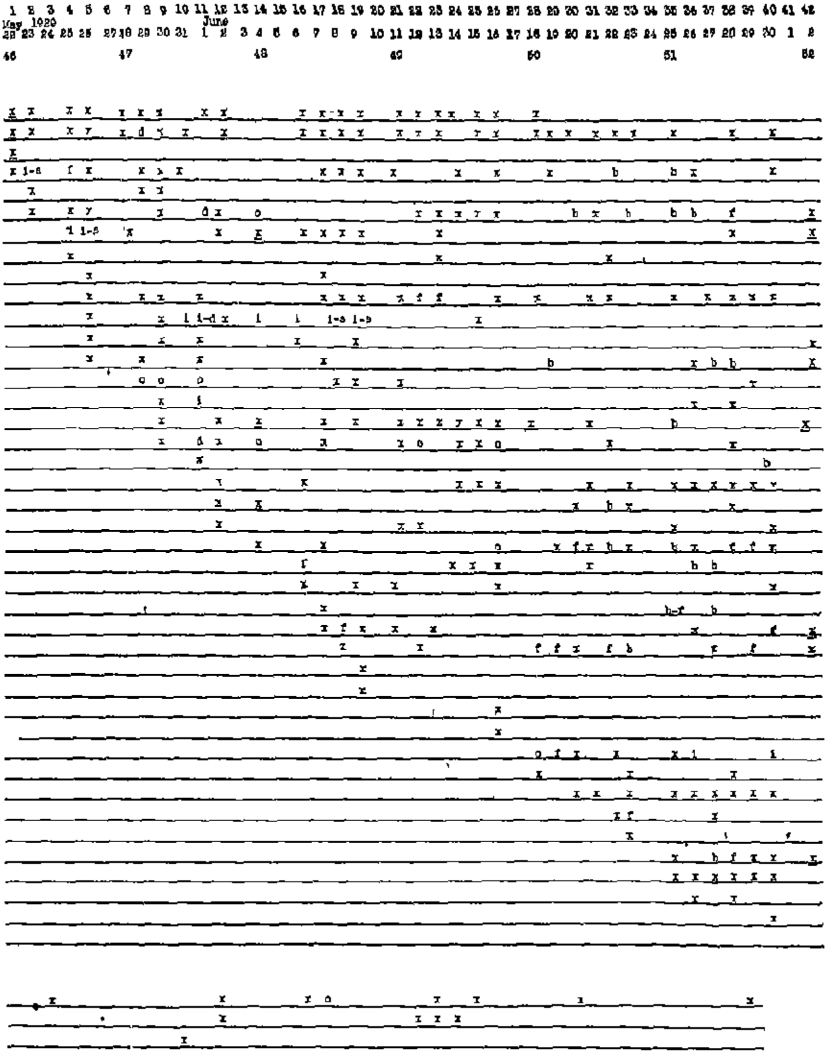

CHART 2 (*continued*)

x—behavior observed
f—frequent behavior
b—behavior with box
d—delayed behavior
o—occasional or low-grade behavior
—behavior displayed by control twin
i—imitative behavior

With the need for caution in mind, the items were examined to see (1) if they denote a real change in behavior, and (2) if that change is part of the progression to more advanced behavior. When such changes are shown, I believe we are justified in saying that we have discerned *growth* changes However, if (1) and not (2) can be demonstrated, then the assumption that growth has taken place is not so clearly justifiable. Arguments on this point will follow a discussion of the items—the next subject for consideration.

Item 1-a, *secures one cube,*
Item 1-b, *accepts second cube, retaining first,*
Item 1-c, *resecures cube as soon as dropped,*
and
Item 1-d, *hits cube against cube on table top,* were observed the first day These items are characteristic of 40-weeks infants. Securing a cube in each hand, they hold it, look at the other cubes, and at the Examiner, if their hold relaxes and they drop one cube, it is immediately resecured They use the cube in hand to approach and hit other cubes on the table.

Item 2-a, *tips cube with index finger, holding cube in hand,* is an advance beyond Item 1-d. Observation of this activity in other infants suggests it is an attempt to secure the third cube, Item 4-c. The record substantiates this interpretation for it continues. "She finally releases one cube and moves hand toward tipped cube but immediately resecures dropped cube"

Item 2-b, *extends cube to Examiner,* has definite normative significance. Every child from early infancy has many things taken from it, but it is relatively late when he finally starts extending or offering objects to people We find it characteristic of about 48-52 weeks level. *Its earlier occurrence in this case is because of the longer period* of observation, 10 minutes, as opposed to the usual 3 to 5 minutes Twin *T*'s previous social behavior had consisted only in looking at the Examiner and in showing animation by becoming active and waving her arms It will be noticed that on the 42nd day both twins displayed this behavior in the test situation.

Item 3-a, *hits cube against the table top imitatively* Spontaneously hitting the cube against the table top is an activity which reaches a peak at 32 weeks. As imitative behavior it is more advanced than as spontaneous activity. It was not until the 4th day that it could be incited by the Examiner's example.

Item 3-b, *vocalizes when cubes are removed* The first protest to

the withdrawal of objects is crying. If an infant is not "spoiled" he usually learns to accept the situation, but frequently, with the development of language, we find the infant resorting to a mild vocal protest. It is his more mature way of making his wants known, but less mature than the verbal, "No" Until the 4th day this infant had merely accepted the end of the situation Obviously vocalization of this type would not occur if the infant were not interested in the cubes or if he were very much disturbed by their removal In the first case he would probably resort to his less mature behavior, crying. The occurrence of this behavior is indicative of a certain maturity but lack of its occurrence does not indicate lack of maturity

Item 4-a, *hits cube against crib platform* Hitting the cube against the platform is an advance over Item 1-d. There will be noticed a constant widening of the child's field of activity At first his play is confined to the table top before him; he then turns to the platform on which he is sitting, incorporating that in his play; then to the side panel of the crib, Item 6-b; the floor, Item 9; and the wall, Item 10-a. These objects apparently are discovered as his toys are brought fortuitously into contact with them or as the development of his locomotor urge results in a changed orientation, bringing new parts of his environment within his widening attention span The order in which the child's surroundings are incorporated in his play depends upon their spatial relation to him and in any given situation this order can be predicted almost with certainty

Item 4-b, *vocalizes during play activity* Early vocalization during play is common, but as the child grows older his play activity is so absorbing that vocalization drops out It is at this age that banging is very frequent (32 weeks) and it in turn decreases in frequency as vocalization reappears again At the 40-weeks level 27% of the infants in our normative studies vocalized during the multiple-cube situation, while 41% displayed this behavior at 44 weeks Although vocalization occurred first on the 5th day of the experiment, it will be seen that it was not until the 22nd day that it became a prominent part of the activity.

Item 4-c, *secures two cubes in one hand.* The infrequency with which this behavior appeared on subsequent days suggests that it may have been a fortuitous occurrence Nevertheless, the facts that it did happen is significant for it is undoubtedly an advance over previous behavior now 3 or 4 cubes instead of 2 can be held at once

Item 4-d, *hits cubes together, pat-a-cake fashion* Holding a cube

in each hand and hitting them together normatively follows holding two cubes and hitting them against other objects, Item 1-d. Bringing two objects together may involve a higher form of attention, but, on the other hand, the explanation may be due merely to the difficulty of the abductive movements

Item 4-e, *hits cube about on table top using cube in hand*, occurs as the cube in hand hits the cube on the table more laterally. It is possible that the child is attempting to repeat Item 4-c and, failing, he pushes the cube from position, this result satisfies him and he continues it Item 10-b is a further extension of this activity.

Item 5-a, *carries cube from table top to crib platform* This behavior differs from Item 4-a in that it is a more direct turning to the platform; Item 4-a occurred some time after the cube had been taken from the table The peak of this behavior normally occurs at 44 weeks. This transferring activity increases in complexity as it becomes integrated with advancing locomotor activities Item 8-a may be regarded as the next step in transporting cubes.

Item 5-b, *vocalizes when talked to* Of course vocal response can be socially stimulated very early, but there was no conscious attempt on the Examiner's part to elicit vocalization. Instead, the child was talked to merely to stimulate cube play. When the stimulus is as mild as in this case, vocal response is much more mature behavior and surely indicates a stronger vocalization urge than Item 3-b and a less mature activity than the conversational jargon of 18 months.

Item 6-a, *releases one cube over another*. The child once secured two cubes in one hand (Item 4-c) He may be attempting to repeat that performance and as he opens his hand to take the second cube the first falls out From that point of view his present behavior is inferior to his former performance, but, from another point of view, this new behavior is seen to be an early stage of tower building. It is our opinion that infant behavior very frequently presents this paradoxical picture of regression and growth When the mother sighs and says, "Why, Johnnie did that a month ago, but he can't do it now," it means not that the child has returned to a more immature response but that instead he is acquiring new ways of reacting that in turn set the stage for future growth Infant behavior growth is not merely doing something better and better; it is a much more intricate process than that. Its course is revealed only when carefully and intensively studied: mere logic fails to expose it.

Item 6-b, *hits cube against the crib side rail*. The appearance of

this item illustrates the widening of the child's field of activity discussed under Item 4-a. It is a step between Item 5-a and Item 9.
Item 6-c, *releases cube to Examiner.* It is interesting to note that this is the second new item appearing on the 9th day which involves releasing ability a fascinating and well-defined bit of behavior for genetic study Releasing develops later than prehension. At first an infant, holding two cubes and presented with the third, will reach out, dropping the object which he is holding as his hand opens to take the third, and he disregards the dropped object With increasing age he is attracted to the dropped object, ceases to reach for the third object, and resecures immediately what he has dropped, Item 1-c At a still later age he retains both cubes, using them to hit the other cubes Gradually he definitely drops one cube and picks up another, Item 12 Releasing a cube to the Examiner also has a social aspect. It is an advance over the Item 2-b and leads to that stage when the child brings and gives you everything he finds As an item of social behavior it is clearly indicative of growth
Item 7, *scatters cubes, brushing with hands* Why scattering the cubes by brushing them with the hands should appear in the behavior picture at this time is not clear. The only explanation that the author can give is that the cubes were accidentally brushed, due to the increasing vigor of the child's play, and that satisfaction in the activity stimulated its continuance. If one considers merely the growth in ability to scatter the cubes, regardless of how the result is accomplished, we see that this behavior is more effective in its results than Item 4-d and less effective than Item 19-a, and in that sense it is an item representing a stage of growth
Item 8-a, *creeps with cube in hand,* has been preceded by turning from the given position to perform Items 4-a, 5-a, and 6-b Obviously creeping with the cube in hand is a more advanced accomplishment, though less advanced than standing.
Item 8-b, *lifts cube high and drops it* Lifting of the hands up high is a common activity of this age in which the baby game, "How big is baby?—So big" has its origin Dropping the cube with the hand up high is merely an integration of the "So big" and cube-releasing activity. Its appearance at this time in the behavior of the control twin is a proof of its fundamental character It may be a part of increasing tendency to scatter the cubes about, more advanced than Item 7, and less advanced than Item 11-a
Item 8-c, *rubs hands back and forth on table top* After the cubes

have been scattered, as in Item 7, the child continues rubbing his hand back and forth on the table top, derives satisfaction from the sensation, and continues his activity. This behavior leads to Item 11-b, a response noted in both infants on the 42nd day

Item 9, *drops cube to floor over crib side rail,* is a combination of Item 6-b and dropping the cube It is the step between Item 6-b and Item 10-a.

Item 10-a, *hits cube against wall* See Item 4-a and Item 9.

Item 10-b, *hits cube to platform with cube in hand,* is more effective than Item 4-e, but to what activity it leads is not clear

Item 11-a, *throws cube on table top,* a step between Item 8-b and Item 19-a.

Item 11-b, *rubs cube back and forth on table top.* With a cube in each hand, this activity of rubbing the cube back and forth against the table top became so vigorous on the 18th day that deep red marks were left on the gray table. See Item 8-c. Although this activity has frequently been observed in normal infants, it does not reach a high frequency at any one age. Chart 2 indicates that it remains in the behavior picture for 25 days and that the control twin also indulged in it on the 42nd day. However, as a growth activity, its significance is not evident, and, therefore, at present we will consider it to be merely exploitive play which does not lead directly to further activity—a *pure research* enterprise on the infant's part.

Item 12, *drops one cube to take another.* The genetic aspect of this item is discussed under Item 6-c This activity becomes more and more prominent in the behavior pattern until the child is able to secure without fail more than two cubes at once, it then begins gradually to disappear from the picture.

Item 13-a, *secures cube between index fingers* Holding a cube in each hand, a third cube is attained between the two extended index fingers Not since the 5th day has the infant secured in any manner the third cube, but now, with the prominent activity of the index fingers, a new solution is discovered It is not a satisfactory one, for a slight movement of the hands results in dropping the cube. This behavior is replaced 5 days later by that indicated by Item 14-b.

Item 13-b, *scratches cube with index fingers.* Scratching which involves the simultaneous flexion of all digits is characteristic of 20-weeks maturity, but scratching with merely the independent action of the index finger is a much more mature response. While we have no normative data concerning the behavior item, it has been observed

incidentally in other infants to function sometime between 46 and 52 weeks. Its appearance precedes further activity utilizing the index finger, such as described by Item 17

Item 14-a, *holding two cubes, attempts to store one cube and secure third* Securing a third cube between the index fingers, Item 13-a, was by no means a successful method of acquiring the third cube Storing one cube to take the third is the method which will be used when the child is older In this manner a number of objects can be accumulated

Item 14-b, *holds third cube between two, one in each hand.* Failing to store a cube the infant resorts to a modification of Item 13-a which results in a firmer grip on the third cube due to the larger surface of the side of the cube as opposed to the index finger surface. It is a better temporary solution than Item 13-a which will be replaced by success in Item 14-a.

Item 15-a, *releases cube in box* Behavior on this day cannot be compared to that on former days because the situation now involves a small red wooden box. Behavior which concerns merely activity with the cubes is checked opposite the old items, behavior with the box, like that observed with the cubes, is indicated opposite the items for the cubes but checked with a *b* instead of an x It is significant that the same activities are performed with the box as were observed with the cubes, illustrating the fundamental character of the activity Although to an adult the box may be regarded as a large cube, hollowed out on one side, to a child it presents a different problem in prehension and manipulation

Item 15-b, *releases cube on shoe* See Item 15-a

Item 16, *cruises with cubes.* The urge to cruise is now becoming stronger, and the child arises to his feet and starts to get about the crib When reseated, he accepts the position and continues his play with the cubes He has developed beyond mere creeping with the cubes, Item 8-a, but he does not yet persist in standing to play with the cubes, Item 19-b.

Item 17, *pokes cube, using index finger* As forecast in Item 14-a and Item 14-b the index finger is coming into prominent and frequent use. The child now, instead of using a cube to hit and push a cube about, is using his index finger. Although the observations are not continued until the next stage of growth emerges, we know sufficient concerning the later use of the index finger to recognize in this behavior a growth value.

Item 18, *opens hand, lets cube roll out.* Releasing ability is showing marked improvement, the slow opening of the hand, palm supine, allowing the cube to roll out, is an activity requiring skill in coordination During preschool life, while playing with sand and water, the child brings the activity into frequent use

Item 19-a, *casts cubes about vigorously* Item 11-a has developed into vigorous and frequent behavior The casting is so strenuous that the cubes fall over the table top to the platform, and frequently to the floor Aim is inaccurate It is in this respect that improvement in the activity later occurs

Item 19-b, *insists on standing for cube play* See Item 16. The child has acquired the skill to stand and, at the same time, play with the cubes. He adjusts to equilibrium, although play involving arm activity is constantly disturbing his balance This is merely a step, as we all know, to even finer balance

Item 20, *places cube on cube, releasing cube in hand* Releasing one cube over another, Item 6-a, occurred on the 9th day, but it was not until the 36th day that a cube was placed *on* another cube and released A tower did not result because the cube was hit as the hand was lifted. We regard this as incipient tower building—a more mature achievement which is invariably present in later behavior

Item 21, *taps one cube on top of another.* This item differs from Item 1-d in that it is a repeated, less vigorous, more restrained activity. Its occurrence at this time is not clear unless, unsuccessful in building a tower, Item 19, the infant retains the cube and taps with it instead Since observation stops on this day it is more difficult to interpret the item It may not represent a stage of development but rather merely exploitive activity

The unnumbered items, separated from and at the end of the list, indicate to some extent the child's emotional state during the periods of observation They need no comment at present, but will be referred to later.

For the reader's convenience, the items considered to have growth significance are indicated by *1* and *2* on the chart. Letters at the left of the items designate the functional value of the item—a subject for later discussion.

Inspection of Chart 2 will show that the majority of the items are indicative of growth changes. Do the remaining items, designating behavior merely new to the organism, show growth, or are they a manifestation of some other process? On examination they will be

found to represent what we will call *exploitive play* Play of this character is undoubtedly instrumental in accumulating experience on which further activity may at some later and indefinite day be founded. Its value is unquestioned, but its claim to growth status is debatable, therefore, since we are interested in definite growth changes, items of this character will not be considered indices of advancing development It is very probable that the character of this *exploitive activity* is the indicator for individual differences and levels of intelligence While we have found that in infancy the defective child advances at a rate slower than normal, we usually have not seen a corresponding acceleration in superior infants. Several instances of an unusual play activity in the behavior of infants who later showed signs of superior endowment suggest that the exploitive play may be of real value in the prognosis of individual deviations in intelligence. A recent unpublished study by Jacobsen and Yoshioka (3) of the development of a chimpanzee again suggests this point of view. Waving objects, banging them, pushing them, pulling them, etc, are all activities particularly conspicuous by their absence in the animal's early behavior

The question is raised, however, whether we should, in general, give status to exclusively exploitive behavior in a scale designed to measure growth It is probable that some exploitive behavior is so likely an outgrowth of a certain age level pattern that its occurrence furnished an indirect measure of maturity, but that its absence is meaningless except as an individual characteristic. In that case, since we need all the available data contingent on the determination of growth levels, the indirect positive indicator should be incorporated with appropriate function in a scale for measuring behavior growth Our unpublished normative studies show that Items 4-d, 4-e, and 11-b are undoubtedly significant of the growth stage at which we find them occurring here, but since their inclusion changes but very little the results which follow, they will not be so included.

Another more immediate question is If, when advanced behavior is displayed on a certain day, maturing behavior in another field of activity noticed on the previous day does not occur, has the child progressed, regressed, or both? It has been assumed that advance in response in any aspect of behavior was sufficient to say that the child as a whole had progressed. For example On the 19th day, when the infant started cruising with the cubes in hand, finer manipulatory play with the blocks did not occur, the two performances were in-

compatible We have assumed, however, that the past behavior, unless contra-indicated, remains a part of the infant repertoire and that, by widening his scope of activity, he was laying the foundation for an even more advanced stage: that of cruising simultaneous with manipulatory activity with the cubes.

Limiting the assumption of growth indication to those items about which we were most confident, that is, items fulfilling both conditions *1* and *2* as stated earlier, data given in Table 1 were computed. Behavior observed on each day was compared, when possible, with that on the previous day; based on the total number of days comparison was possible, percentages were derived for: (1) the number of days showing growth; (2) the number of days showing regresssion, and (3) the number of days showing no advance and no regression. In the same way, behavior on alternate days, every 3rd, 4th, 5th, 6th, 7th, 8th, 9th, and 10th days was compared.

On the 7th day, instead of making a new item for imitatively hitting two cubes together, a more mature response than spontaneously doing it (see Item 3-a), an *i* was used in checking Item 4-d. Therefore the 7th day, while not showing advanced behavior on the chart, has been counted as a growth day In the same way, on the 19th day the frequent releasing of the cube in the box was indicated by *f* There was a decided improvement in her effectively putting the cube in the box, and, therefore, that day also has been included as one showing progressive behavior

Since daily weights for the infant during the experimental period were available, similar computations were made for ponderal growth (Table 2)

The weight was always taken at 8 A M., before the bath, eliminating the fluctuations due to time of day. Growth in weight affords a fitting comparison with growth in behavior because both represent a summation of changes in the total organism, even though the Ex-

TABLE 1
PERCENTAGE OF DAYS SHOWING BEHAVIOR GROWTH

Time interval in days		1	2	3	4	5	6	7	8	9	10
No days compared		*25*	*26*	*25*	*23*	*23*	*22*	*26*	*21*	*21*	*20*
Percentage	Progression	60	64	80	78	83	86	92	90	100	100
of days	No change	8	16	8	13	4	5	0	0	0	0
showing.	Regression	32	20	12	9	13	9	8	10	0	0

TABLE 2
PERCENTAGE OF DAYS SHOWING WEIGHT GROWTH

Time interval in days		1	2	3	4	5	6	7	8	9	10
No days compared		24	26	22	22	24	21	24	20	23	19
Percentage	*Progression*	*46*	*65*	*64*	*73*	*66*	*76*	*83*	*90*	*74*	*84*
of days	No change	8	4	9	9	17	5	5	5	9	0
showing	Regression	46	31	27	18	17	19	12	5	17	16

aminer attempted only to motivate cube play, any aspect of the infant's behavior was noted, regardless of its function

Daily growth in behavior is shown on 60% of the days, while at intervals of 7 days it was almost invariably evident Daily growth in weight in the same infant during the same period was indicated on 46% of the days and at intervals of 8 days it, too, was almost invariable. That behavior changes are occurring as surely and rapidly as physical growth changes is not an over-statement.[1] In fact, it is very probable that with increased keenness of observation and improved techniques in method we will find behavior even more dynamic than physical growth Below 52 weeks, then, a scale with weekly intervals is practicable even with our present crude methods

To study the nature of the growth increment it will be helpful to functionally analyze the items This functional assignment could be carried to extremes, as many functions as there are activities could be listed. To analyze the more outstanding aspects of developing abilities is, however, helpful if we recognize their arbitrary character. Inspection revealed seven rather clear-cut functions. *s,* social behavior; *l,* locomotive behavior; *c,* cube-combining play; *p,* exploitive play, *r,* releasing activity, *b,* attentional span, *a,* acquisitive behavior Letters at the left of the items indicate the functions considered to be involved The most evident fact is that several functions are developing at once, on any one day we find behavior in different functions advancing; for example, locomotion and vigorous casting of the cubes occur on the same day The new items in the various fields occur at different intervals The fact that these intervals are of varying

[1]Although we find that in this case behavior growth parallels physical growth, it does not necessarily follow that such is always the case In fact, the contrary has frequently been observed We have seen loss in weight over a four-week period accompanied by a four-week gain in adaptive behavior. Mental growth may be quite independent of physical growth as expressed in weight

TABLE 3

Regression interval in days	1	2	3	4	5	6	7	8	Total
No days showing decrement	–	3	1	1	–	1	–	1	7

lengths may be because only the observed behavior is recorded here Just because we were not keen enough to see an intervening stage of behavior does not mean that it has not been there to be observed

Since the nature of the decrement is as important as that of the increment, we will consider what happens when behavior regresses Table 3 indicates the number of days showing a decrement when compared with the previous day The regression interval[2] is expressed in days.

The three days showing a regression interval of two days are. the 19th, the 37th, and the 39th day. Referring to the records, we see that the lapse is because of the absence of a certain response[3] which occurred for the first time on the previous day. Item 12 on the 19th day and Item 20 on the 37th and 39th day Tracing the course of the appearance of Item 12, we find that it is not frequent behavior until 10 days after its appearance If the play period had been longer than 10 minutes, it is possible that this developing behavior would have been observed. On the other hand, it may be that this early behavior is quite fortuitous though significant in a growth manner and that the concourse of circumstance was not as favorable to the behavior as it was on the previous day. In either case the apparent regression would not be a true one On the one day (10th) when the regression interval was 3 days, the infant was fretty Although her temperature (rectal) was only 98°, she was undoubtedly slightly indisposed She did not play with the cubes in the more immature manner seen at first, instead, she could not be induced to play with them at all, and fretted at every approach of the Examiner.

The day of the 4-day regression interval (22nd day) was characterized by an absence of index-finger activity It was on that day that her vocalizations during play increased markedly in frequency. The vocalization undoubtedly absorbed her attention and excluded the fine eye-hand coordination involved in the precise index-finger ac-

[2]By regression interval is meant the time between a day of regressive behavior and the previous day when behavior as advanced as that on the day of regressive behavior was observed.

[3]The assumption on page 30 is not so justified in the absence of a more advanced behavior incompatible with the lapsed behavior.

tivity Behavior on the following day (the 23rd day) showing the 6-day regression interval is found to be explained in the same way. Then her vocalizations became squeals and laughters. The next day (the 24th day) we find the greatest regression Creeping with the cubes in hand is the dominant activity and, like vocalization, it, too, excludes the finger motor responses of the previous days

The day following these three days of steady regression we find that vocalization, creeping, and advanced fine motor activity with the cubes are all evident in the infant's repertoire Several instances of this phenomenon of an activity being present, dropping out as new behavior appears, and then reappearing in connection with the new activity can be pointed out on the chart See Item 4-e and Items 5-a and 5-b; Item 7 and Items 8-a and 8-b, Item 10-b and Item 11-b; Item 16 and Item 17

It is significant that on days showing a decrement, as we have defined it, there is not a reversion to an earlier behavior pattern, but it is rather suggested that these days may really be days of growth The one exception was when the child was very fretty, but even then she did not truly revert—instead she refused to play with the cubes.

Viewing the occurrence of any one item of behavior from day to day, it is noticed that it is not unusual for specific behavior to occur on one or two days, drop out of the picture, and then occur with frequency Are these early manifestations the infrequent occurrences of a maturing function or are they chance behavior which, after being experienced by the child, are repeated by him first with mild enjoyment and then greater enjoyment and consequently with greater frequency?

It will also be noticed that some responses continue to function as the infant grows older, while other responses are more transient in character Would the transient behavior be a more accurate age indicator because it occurs within a narrower range of time? If it occurs for a short but specific stage of growth, we might find it occurring with slight frequency at a specific age in a group of normative children. There would be danger, then, of discarding most valuable indicators of growth if the selection of items were on a strictly percentage basis

Does it mean that because behavior, as we describe it, is in some respects transient that this is the nature of a phase of growth?—Not necessarily Our descriptions, being man-made tools, reflect more ourselves than they do growth—this will always be true of any

studies we make and therefore the problem must be approached from many points of view to secure the more universal truth.

In summary, we find that daily observation of behavior in a selected, controlled and defined period indicates that behavior growth proceeds fully as rapidly as physical growth. The growth increment is in different functions on successive days but may be in more than one function on the same day. The behavior growth increment manifests itself in: (1) the greater frequency in one item of behavior; (2) the improved performance of an activity; (3) the appearance of a new activity, and (4) the integration of previous activities. Some items of behavior are permanent, others are transient. Transient behavior may have as great or greater significance concerning the stage of growth as more permanent behavior. When the infant is apparently regressing in behavior, it does not respond in a more immature manner but occupies itself with a functionally more confined repertoire but yet characteristic of its age.

Scales designed to indicate growth may profitably include behavior *not itself a stage of growth, if that behavior is sufficiently indicative* of a growth stage. The frequency of occurrence of behavior in an *age group should not be the only criterion for its inclusion in a behavior* scale. Other factors, such as transitoriness, are important. In infants, a study of exploitive play may be found to reveal more than growth rate does concerning future intelligence level.

It is relatively easy to test a group of children at different ages and to devise a scale using the established techniques; it is important that this be done, but it is important, too, that we study the nature of growth to see if our mensurational technique cannot be improved and refined. Greater intimacy with the developing organism is a necessary part of our own progress in measuring the growth of man.

References

1. Gesell, A. Infancy and human growth. New York: *Macmillan*, 1928. Pp. xvii+418.
2. Gesell, A., & Thompson, H. Learning and growth in identical infant twins: an experimental study by the method of co-twin control. *Genet. Psychol. Monog.*, 1929, 6, 1-124.
3. Jacobsen, C., & Yoshioka, J. *The anatomical and behavioral* development of a female chimpanzee during the first year of life. (Paper presented at the Thirty-ninth Annual Meeting of the American Psychological Association, Toronto, Ontario, 1931.)

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LA CROISSANCE ET LA SIGNIFIANCE DES VARIATIONS QUOTIDIENNES DANS LE COMPORTEMENT DES ENFANTS

(Résumé)

L'observation quotidienne choisie et contrôlée du comportement d'un enfant âgé de 6 semaines pendant six semaines indique que la croissance du comportement a lieu aussi rapidement que la croissance physique L'accroissement se trouve en différentes fonctions aux jours successifs mais peut être en plus d'une fonction le même jour L'accroissement du comportement se montre en (1) la plus grande frequence d'un type de comportement (2) un meilleur rendement d'une activité, (3) l'apparence d'une nouvelle activité, et (4) l'intégration des activités antérieures Quelques types de comportement sont permanents, d'autre ne le sont pas Le comportement non permament peut être aussi significant ou plus significant à l'égard de l'étape de l'accroissement qu'un comportement plus permanent Quand l'enfant semble marcher en arrière dans son comportement, il ne répond pas d'une manière moins mûre mais s'occupe d'un répertoire fonctionnellement plus restreinte mais cependant caractéristique de son âge

Les échelles faites pour indiquer la croissance peuvent très bien inclure le comportement non lui-même une étape de croissance, si ce comportement indique suffisamment une étape de croissance La fréquence de l'occurrence du comportement dans un groupe d'un certain âge ne doit pas être le seul critère pour son inclusion dans une échelle de comportement D'autres facteurs tel qu'un état non permanent sont importants Chez les enfants une étude du jeu exploiteur peut réveler plus que la vitesse de la croissance à l'égard du niveau futur de l'intelligence

THOMPSON

WACHSTUM UND BEDEUTUNG TAGLICHER VARIATIONEN IM VERHALTEN DER KLEINKINDER

(Referat)

Ausgewahlte und uberpruft tagliche Beobachtungen des Verhaltens eines 46 Wochen alten Kindes wahrend des Zeitabschnittes von sechs Wochen erweist, dass das Wachstum im Verhalten eben so schnell fortschreitet wie das Wachstum des Korpers Die Zunahme des Wachstums manifestiert sich an sukzessiven Tagen in verschiedenen Funktionen, aber auch in mehr als einer Funktion an ein und demselben Tag Die Wachstumszunahme im Verhalten aussert sich (1) in der grosseren Haufigkeit einer Einzelheit des Verhaltens, (2) in der besseren Verrichtung einer Tatigkeit, (3) im Aussehen der neuen Tatigkeit, und (4) in der Vervollstandigung fruherer Tatigkeit Einige Einzelheiten des Verhaltens sind bestandig, andere verganglich Vergangliches Verhalten kann eine grosse oder grossere Bedeutung haben fur die Wachstumsstufe als das bestandige Verhalten Wenn ein Kleinkind scheinbar regressiv ist im Verhalten, reagiert es nicht in einer unreiferen Art und Weise, sondern es beschaftigt sich mit einem funktionell beschrankten Register, das aber doch charakteristisch ist fur das Alter

Skalen, die zur Bestimmung des Wachstums aufgestellt werden, werden mit Vorteil Einzelheiten des Verhaltens einschliessen, die an sich keine Wachstumsstufe representieren, vorausgesetzt, dass sie hinreichend deutlich auf eine Wachstumsstufe hindeuten Die Haufigkeit des Vorkommens eines Verhaltens innerhalb einer Altersstufe sollte nicht das einzige Kriterium dastellen fur dessen Einschluss in die Skala Andere Faktoren wie Verganglichkeit sind wichtig. Es wird sich wahrscheinlich erweisen, dass bei *Kleinkindern das Studium der Entdeckungsspiele mehr uber das zukunftige* Intelligenzniveau auszusagen vermag als der Wachstumskoeffizient

THOMPSON

STUDIES OF TRANSFER OF RESPONSE: I. RELATIVE VERSUS ABSOLUTE FACTORS IN THE DISCRIMINATION OF SIZE BY THE WHITE RAT*[1]

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INTRODUCTION

Gestalt theories have stimulated a renewed interest in the problem of reaction to relations. The implication in some of the American exponents [Perkins and Wheeler (11) and Helson (5)] is that relations are perhaps the sole basis of reaction. Kohler (8) holds that the animal learns to discriminate partly on the basis of absolute cues and partly on the basis of relational cues, but that the rate of forgetting differs in the two cases. The absolute cues are forgotten rapidly, while the relational cues are forgotten more slowly.

It has been demonstrated by many workers that the reaction to relationship is important in animal learning. Kinnaman (7), as early as 1902, working on two Macacus rhesus monkeys, used a long series of grays numbered from 1 to 9, 9 being the lightest, and 1 the darkest. He presented the monkeys with adjacent grays, 8 vs. 9, 7 vs. 8, 6 vs. 7, etc., always putting the food with the lighter of the two grays presented. He began his training at the lighter end of the scale, and, at the darker end of the scale, found 83% of correct responses on 2 vs. 3, and 94% of correct responses on 1 vs. 2. He concluded that the monkeys had developed a general notion of a low order expressible as "food in the lighter" of the two. He also found other evidence for the development of a vague general notion by the monkeys. Observing the behavior in solving a series of problem boxes, he noted that on the first problems the monkey, on being given a new box, paid no more attention to the projecting latch or bolt than it did to other parts of the box, while in solving later problems the monkey, on being given a new box, devoted its

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efforts almost entirely to the projecting parts of the box This he again concludes shows a vague general notion expressible as the projecting thing has something to do with opening the box.

Lashley (9), in training rats to size discriminations, found that the animal reacted to the relationship between the stimuli. Washburn (15) showed the same thing for a rabbit trained to a brightness discrimination. Bingham (1), after training chicks to go to the larger of two circles presented, found that "a 'large-small' trained chick reacts positively to the larger of two stimuli even though this particular stimulus had been the 'shock' stimulus in the previous experiment" Coburn (2) tested the crow in a similar fashion with circles of different sizes, and found that it reacted to the relationship between the two circles presented, rather than to a circle of a definite size. Révész (12) trained hens to peck grain from the smaller of two similar figures that were presented to them and found that when they were presented with two congruent arcs of a circle placed close together and parallel the hens went to the one which appears the smaller to human vision, thus securing evidence that hens perceive this illusion in a manner similar to human beings Gotz (4) has shown that when hens are trained to eat only the larger of two grains, they pick the larger one, even though it is at a greater distance than the smaller grain, so that the smaller grain would give the larger retinal image. Helson (5) trained two rats to choose a 60-watt lamp when it was presented together with a 2-cp. lamp, and also trained two other rats to react positively to the 2-cp. lamp and negatively to the 60-watt lamp. After reaching 93% correct responses on this problem, the rats were tested on a 60- vs a 150-watt lamp, and on a 2-cp. vs a 1-cp. lamp. In every case the rats showed transposition, but only 83% correct responses were given in the first test for transposition, as against 93% in the original training. Helson, however, concludes that the drop is not connected with the change of stimuli, but is simply due to the normal variation found in learning performance. Takei (13) has repeated the work on chicks, using both a size discrimination and a brightness discrimination He finds evidence for transposition only in the size series, but in no case requiring transposition does the chick perform with the accuracy it did during the training series.

Johnson (6) trained chicks to respond positively to a field containing striæ of one width and negatively to fields containing striæ of many different widths, but all smaller than the positive field. Later

he presented the original positive stimulus paired with a field containing still wider striæ, and found that in 20 trials the original positive stimulus was chosen 13 times. This perhaps constitutes evidence to show that the chick can be trained to give an absolute response, although the difference is scarcely better than chance. Warden (14) also secured evidence of reaction on an absolute basis. He trained two doves to react positively to a medium gray when it was paired sometimes with a lighter, and sometimes with a darker gray One dove made as high as 82% correct responses, the other 57% correct Warden concludes that it is possible to develop a response on an absolute basis

Perkins and Wheeler (11) have demonstrated that goldfish trained to go to a dimly lighted as opposed to a brightly lighted compartment will, if presented with a dark and a dimly lighted compartment, choose the dark one, and, similarly, if both compartments are brightly lighted, the fish will pick the darker of the two

Gayton (3), testing four rats, found transposition of brightness, but, since the rats' accuracy in the transposition series was less than in the training series, Gayton concludes that the new situation "is regarded (by the rat) as similar, but not identical to (the training series) "

Köhler (8) states, "There is no doubt, now, that a chick, trained with two grays, I and II (II being darker than I), always to choose II, will, after a while, when II and the new (darker) gray III are given, in the majority of the trials not choose II but the unknown nuance III," and also that "the habit depending upon the pair as a whole is more enduring than the habit depending upon the nuance *as such*, since the pair as a whole is relatively less decisive when the animal reacts to the new pair immediately after some trials with the old one"

While everyone now admits the possibility of developing reactions to relationships, different views are held regarding the importance of these reactions. Wheeler and Kohler hold that the reaction to relationships is one of the fundamental facts of learning Warden, on the contrary, states, "Generalizations to the effect that it (reaction to relationships) illustrates a fundamental law of perception are certainly unwarranted on present evidence "

It has been demonstrated by different workers that animals of many different species are capable of reacting to one stimulus of a pair, not as a unit in itself, but according to its relative position in

the pair. It has sometimes been apparent that when the new stimuli were introduced the animals did not perform as accurately as they had with the old stimuli. Varying explanations of these facts have been suggested One group has held that the only basis of the animal's response is the relationship between the two stimuli Members of this group have explained the inaccuracy of transposition by ascribing it to the normal random variation found in any performance Gayton has suggested a different explanation of the inaccuracy of transposition. He holds that it comes from the fact that the situation as a whole is "similar, but not identical" to that in the training series Another group holds that absolute factors play a part This group would probably explain the inaccuracy of transposition as due to the interference of absolute with relational factors

The purposes of the present investigation are: (1) to recheck the fact of transposition, using size discrimination in rats, and (2) to investigate more carefully cases of failure and success in transposition to ascertain, if possible, the relative importance of the absolute and relative characteristics of the stimulating situation in dominating the reactions of the animal

Methods

Training Technique. The training technique used was that devised by Lashley (10), of forcing the rats to jump about 25 cm. to one of two openings, each of which was covered by a cardboard bearing a visual pattern In the present experiment two series of trials were used, a training series, and a test series.

In the training series the rat is to choose the "correct" or "positive" pattern, and avoid the "incorrect" or "negative" pattern. The card containing the "positive" stimulus is held up only by a light weight, so that it falls down when the rat strikes it. The rat then lands on a platform behind the card, where it is rewarded by getting a mouthful of food. The card containing the "negative" stimulus is supported rigidly, so that when the rat jumps to it he is punished by bumping his nose on the card and falling into a net (about four feet) The positive stimulus is sometimes to the left of the negative one, and sometimes to the right, to correct for a position habit.

Definition of a "trial" The rats were given ten consecutive "trials" a day at first, and later this was increased to 20 consecutive trials a day. A trial is defined in the following manner: The cards were kept in the same position and the rat was put back on the

jumping platform as often as he choose the negative stimulus and fell to the ground This was repeated with the cards in the same position until the rat chose the positive stimulus. This series of jumps with the cards in the same position, terminated by one "correct" jump, is called "one trial" by Lashley.

Whenever "one trial" was completed, the cards were either replaced in the same positions, or interchanged (according to a "chance" schedule prepared beforehand) and the rat was then given another trial. Each day this was continued until the rat had made 20 (10 in the early part of the training) consecutive trials.

Definition of "criterion" This training was continued until the rat had reached a certain "criterion" of learning. The criterion adopted was 20 consecutive errorless trials on one day, and the first 10 of the next day's 20 trials also errorless; that is, at least 30 consecutive errorless trials Whenever this criterion was reached, the rat was given a "test" of 30 critical trials

In the "test" series, or critical trials, both cards were held up only by light weights, so that either card would fall down when the rat struck it, allowing him to land on the platform behind the card and get a mouthful of food In the test series, the definition of a trial could not be the same as in the training series, because the rat could not be "punished" with the set-up of the test series In this case, each jump (to no matter which card) constitutes a trial. The rat was given 30 of these critical trials, the first 10 being given immediately after the "criterion" had been reached, and the next 20 were given on the following day

After this the rat was again placed on the training series until it again satisfied the criterion and then was given another test of 30 critical trials, and so on, until all the different test series used in the experiment had been given.

The training stimuli were two cards, each containing a solid white circle on a black background One of the circles was 6 cm in diameter, and the other was 9 cm in diameter Twelve rats were used in this study Six of them were trained "positively" to the 9-cm circle, and "negatively" to the 6-cm circle The other six were trained "positively" to the 6-cm circle, and "negatively" to the 9-cm circle.

The test stimuli were also cards, each containing a solid white circle on a black background Circles of various sizes were used The precise details will be given in the discussion of results

Possible Sources of Error in Interpretation

Adequacy of Criterion The rat was required to make 30 consecutive errorless trials in the training series, immediately before starting on the 30 trials of the test series. Then it was assumed that the errors made in the test series were primarily due to the type of stimuli used in the test series, and not to some irrelevant factor such as fatigue on the part of the rat, or imperfect learning in the training series, etc. The assumption involved here is that, after the rat has reached such a criterion, the next 30 trials will be practically errorless if no change is made in the situation.

It seemed advisable to test this assumption and also the assumption that giving no punishment in the test series would not alter the response. This was done by giving 8 of the 12 rats a test series using the very cards that had been used in the training series, to see if they made what could be regarded for all practical purposes as a zero error score. The number of errors in 30 trials for each of the 8 rats was zero for five rats, and one each for three rats, or an average of about 0.3 errors in 30 trials. This shows that after reaching the criterion demanded in this experiment the next 30 trials give an approximately zero error score.

Possibility of Reaction to Secondary Visual Cues on Cards. After the animals had been given several transposition tests it was noted that the cards used in the training series had slight scratches, smudges, frayed edges, etc., and it was possible that the rat was reacting to these secondary cues, and not to the size of the circles, which the experimenter regarded as the primary characteristic of the cards. Two different methods were used to check on this possibility. First, fresh cards, one containing a 9- and the other a 6-cm. circle were substituted in one of the test series. This removes the secondary visual cues and leaves only the size of the two circles, which the experimenter regards as the primary characteristic of the cards. The resulting number of errors in 30 trials for each of 12 rats was 0 errors each for 8 rats, 1 error each for 3 rats, and 3 errors for 1 rat, or an aveage of 0.5 errors in 30 trials. This means that there is no evidence of any disturbance produced by removal of the secondary visual cues. Secondly, the difference in size of circles (primary characteristic) was eliminated, but the animal was given the secondary cues alone to react to. The 9-cm. card of the training series was removed and in its place a fresh card with a 6-cm. circle was paired with the old 6-cm. circle. In another test series, the 6-cm. card of

the training series was removed and in its place a fresh card with a 9-cm. circle was paired with the old card containing the 9-cm. circle This meant that the rat could use only the secondary cues to differentiate the two cards. When scored on the basis of ability to react correctly to the secondary visual cues the average error was 14.25 in 30 trials This is a chance error score.[2]

These tests indicate that secondary visual cues may be neglected, for there is no evidence of disturbance when these cues are removed, and there is practically no evidence of reaction to the secondary cues alone, when the primary cues are removed

Tests for Transposition

Six rats (half of the group used) were trained positively to the 9-cm. circle and negatively to the 6-cm. circle, while the other six rats were given the reverse training The results on transposition are given first for both of these groups combined, and then for the two groups separately to test the effect of the direction of training upon transposition in either direction from the standard size of stimuli

Efficacy of Relational Factors When Opposed by Absolute Factors When the rats had reached the criterion with the 6 *vs* 9 discrimination required in the training series they were tested for transposition. One-half were tested on 13 *vs* 9 (using the card with the 9-cm circle that had been used in the training series), and one-half on 6 *vs* 4, (using the card with the 6-cm circle that had been used in the training series) Then both groups were retrained to the criterion with 6 *vs* 9, and each half of the group tested with the series the other half had just completed.

With regard to the test on 13 *vs* 9, we have the following possibilities: If the rat has been trained to react positively to the 9-cm circle during the training series, when confronted with 13 *vs* 9, (*a*) he may react positively to the 13, in which case he has probably formed the habit of reacting positively to the relation "larger of the two stimuli presented" If failure to react relationally is scored as an "error" in these critical trials, then the adoption of a relational

[2]One of the rats which had been trained positively to the 6-cm circle, when tested on 6 *vs* 6, jumped to the right regardless of the position of the cards in the first 10 trials, and then apparently picked up some old absolute cue on the 6-cm circle it had been trained to react positively to, for it reacted correctly to these secondary cues in all but 3 of the last 20 trials

mode of response by the rat will give an error score which approximates zero rather closely Or (*b*) he may react in a random fashion, or adopt a position habit. If failure to react relationally is scored as an "error," then the random jumping, or the position habit, will give a score of about half errors (in 30 trials, approximately 15 errors would be an indication of this type of habit). Or, again, (*c*) he may react positively to the 9, in which case he has formed a habit dependent upon the absolute factors associated with the 9-cm. circle. On the above definition of "error" this type of habit will be manifested by a score which approximates all errors (in 30 trials, approximately 30 errors would be indicative of a response based on absolute factors). If, during the training series, the rat has been trained to react negatively to the 9-cm. circle, then we have the same three alternatives, which will be indicated by the same type of error score.

In 30 critical trials with 9- and 13-cm. circles, 12 animals (the entire group) gave the following error scores.

													Average
First test	7,	0,	2,	4,	15,	10,	1,	6,	3,	0,	2,	9	5 0
Second test	8,	0,	2,	14,	14,	0,	5,	13,	13,	4,	6,	0	6 5

This gives clear evidence for transposition in two or three animals, somewhat ambiguous scores in seven or eight animals, and nearly chance scores in two animals. In no animal was there better than a chance score in reaction on an absolute basis. In this case it seems clear that the animals tend to react on a relational basis, although less accurately than to the stimuli used during training, and that when the reaction does not show evidence of a relational basis the animal jumps at random. In no case is there the slightest indication of reaction to the absolute size of the stimulus

The tests for transposition downward with the 6- vs 4-cm. circles gave the following error scores with 12 animals·

													Average
First test	14,	3,	15,	15,	6,	16,	14,	8,	15,	2,	15,	11	11
Second test	14,	1,	15,	9,	14,	15,	8,	14,	6,	14,	11,	7	11

Here, again, we have clear evidence for transposition on only one or two animals, ambiguous reactions in five or six animals, and approximately chance scores in about five animals, and, again, none gave anything approximating evidence for reaction to the absolute size of the stimulus The results differ from those of the 13 *vs* 9 test primarily in that there is here much more evidence for a breakdown of the effects of training.

TABLE 1

NUMBER OF ERRORS MADE IN 30 TRIALS BY EACH OF 12 RATS ON TESTS ON TRANSPOSITION TO 6 *vs* 4

First test Trained positively to 9-cm circle	 6-cm circle	Second test Trained positively to 9-cm circle	 6-cm circle
14	15	14	9
3	6	1	14
15	16	15	15
14	2	8	14
8	15	14	14
15	11	6	7

The results just given for the critical trials on 13 *vs* 9 and 6 *vs.* 4 may be regrouped according to the training the animal received (whether positive to the 9-cm. circle, or positive to the 6-cm circle). This regrouping gives the results shown in Tables 1 and 2.

In large part, two sets of error records in Table 1 are identical, so there is evidence of no clear-cut difference dependent on direction of training.

Again, except for a couple of cases, the two series in Table 2 seem to resemble each other. There is evidence of no clear-cut difference dependent on direction of training.

Comparing the results of the first and second tests, we see that the results are quite similar. This shows that these tests are reliable, and that direction of previous training is a negligible factor. With the situation arranged so that the animals might react either upon an absolute or upon a relational basis, evidence was obtained only for a relational basis In no case was the reaction based upon the

TABLE 2

NUMBER OF ERRORS MADE IN 30 TRIALS BY EACH OF 12 RATS ON TESTS ON TRANSPOSITION TO 13 *vs* 9

First test Trained positively to 9-cm circle	 6-cm circle	Second test Trained positively to 9-cm circle	 6-cm circle
7	4	8	14
0	15	0	14
2	10	2	0
1	0	5	4
6	2	13	6
3	9	13	0

absolute size of the stimulus sufficiently to produce an inversion of the relational response However, the accuracy of reaction was reduced in the majority of animals To test whether this inaccuracy of response resulted from conflict between absolute and relational factors, further tests were made from which absolute cues were eliminated.

Efficacy of Relative Factors When Acting Alone. To test this critical trials were given with 7 1/2[3] *vs* 5 and 18 *vs.* 12. In this series both cards were new to the animal, and neither was the same size as the old cards, so no absolute cues (in the usual sense of the term) remained.

In 30 critical trials on 7 1/2 *vs* 5, 12 animals gave the following error scores· 1, 3, 0, 0, 2, 0, 2, 1, 0, 0, 1, 0. Here we have no evidence of a breakdown, no evidence of reaction to absolute cues. All the animals showed clear evidence of reacting on the basis of relational cues. Comparing these results with those of the critical trials on 9 *vs* 6, we find that there is a possible indication of slightly greater disturbance than was produced by the 9 *vs.* 6 control test, in which the circles were the same size as those used during training

Again, counting failure to transpose as an error, 30 critical trials with 18- *vs* 12-cm. circles gave the following error score for each of 12 animals· 18, 0, 30, 15, 15, 1, 27, 23, 16, 0, 4, 14, with an average of 13.5 Here we have three cases of clear-cut reaction to relationship, four or five cases of clear-cut breakdown of habit, one or two cases of a clear-cut adoption of what seems at first sight to be the opposite of a relational habit.[4]

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[3]The 7 1/2-cm card was chosen because it resembled the 6-cm circle of the training series no more than it resembled the 9-cm. circle of the training series Hence, if the rat were reacting on the basis of absolute size of the circles, it would be as likely to confuse the 7 1/2-cm. circle with the 9- as with the 6-cm. circle of the training series

[4]This cannot be regarded as a reaction to the absolute stimulus in the usual sense of the word, but an explanation of the phenomenon may be offered All those cases that showed an approximation to 30 errors in thirty trials were rats that had been trained positively to the 9-cm circle, and negatively to the 6-cm circle Furthermore, the holes (blocked by the cardboard) through which the rat jumped were 6″ square, so that all the test stimuli from the 4-cm circle to the 13-cm circle appeared, when in place, as a circle inside of a square outline. The 18-cm. circle, however, was so large, that it had to be put on the outside of the opening, and gave a quite different pattern, not a circle inside a square, but a circle overlapping the square opening Then, in order to jump to the same general pattern of circle inside square, the rat would have to choose the 12-cm. circle as opposed to the 18-cm. circle When the rats trained positively to the

There is, however, in this test not the same type of ambiguous response that was found in the other tests That is, cases of 6, 8, 10, or 12 errors, which do not give clear evidence for either transposition or a breakdown, do not occur.

If we make the assumption that it takes the rat 15 of the 30 trials to get "oriented" or to "learn" to adjust to the new situation, and hence inspect the results from the last 15 trials, we find that (1) five rats jumped left in every one of the last fifteen trials, (2) four rats reacted to relationship in every one of the last fifteen trials, and (3) three of the rats, in every one of the last 15 trials, reacted opposite to what would be expected if the reaction were on the basis of relationship That is, in these last 15 trials, there was not any evidence of ambiguity in the rats' responses even to the extent of a single case of divergence from the mode of reaction assumed During the last 15 trials all the rats exhibited a definite reaction, and about the same number had chosen each of the three possible types of response.

These results demonstrate that, with absolute cues ruled out, a clear-cut reaction to relationship is given by a majority of the animals only when there is a rather slight deviation from the training situation Given a greater deviation from the training situation, the animals show more marked evidence of having individual differences in the type of habit which they adopt.

Discussion

The only test in which all the animals showed clear evidence of reacting on a relational basis was that in which 7 1/2- *vs* 5-cm circles were used In the other tests only a few animals (10% to 40%, varying with the test used) reacted clearly on a relational basis In the majority of animals there is neither reaction solely on an absolute basis or solely on a relative basis, but either a reaction partially on a relative basis, or a complete breaking down.

If the rat's reactions are made solely upon the basis of the rela-

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6-cm circle made this choice it could not be distinguished from reacting relationally, and none of the rats trained positively to the 6-cm. circle showed any evidence of responding positively to the 18-cm. circle. Of the six rats trained positively to the 9-cm circle, one reacted clearly positively to the 18-cm circle, four showed fairly clear response to the 12-cm circle, and one adopted a position habit The reaction to the 12-cm circle may be interpreted as the reaction to the pattern of relationship "circle inside square" instead of to the relationship "larger than"

tionship between the two stimuli, why is there a disturbance with change in the size of the stimuli? Various possibilities have been suggested Helson suggests that the decreased performance found on testing with new stimuli can be explained on the basis of normal random variation in the performance of the animal. Such an explanation is ruled out in this experiment by the tests made with 9- *vs* 6-cm circles This showed that, when the test stimuli were the same as those of the training period, the variation did not occur, so the variation was not random Kohler suggests that the animal learns two things, (1) to react to a particular stimulus, and (2) to react to a relationship between stimuli, and that the first of these fades away quicker than the second. But this hypothesis does not explain why there was a disturbance of the reaction to relationship in the cases where the relational factors were not opposed by absolute ones

Another variant of the hypothesis suggested by Kohler would be that the animal's reaction has been aided by the presence of secondary cues. But, although there is evidence that secondary cues play a part in determining the reaction, they are not sufficient to account for the breaking down of the relational habit. When fresh cards are used (thus removing secondary cues), the reaction is undisturbed if these cards are the same size as the training stimuli, but very markedly disturbed if the new cards are different in size from those of the training period.

There is also the possibility that there may be some absolute basis for reaction, primarily to one aspect of the training situation. That is, some animals may be primarily learning to avoid the negative stimulus, others may be learning primarily to seek the positive stimulus But, again, the data show that transposition tests which require the animal to make a positive response to a formerly negative stimulus give results not particularly different from tests which require the animal to make a negative response to a formerly positive stimulus. While it is true that transposition to smaller sizes did not occur as readily as transposition to larger sizes, still some cases showed it clearly either way.[5] Thus, transposition is not completely blocked in any direction.

Another possibility is that the similarity of the absolute situation

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[5]Dr K S. Lashley tells me that he has been unable to train rats to jump to a single stimulus object of less than 4-sq -cm. area The reason for this is not clear, but the fact probably accounts for the greater inaccuracy which we have found in transposition downward

as a whole is a factor. This hypothesis is substantiated by the fact that the test on 7 1/2 *vs* 5 showed the fewest errors, and is likewise the most similar, as a whole, to the training stimuli of 9 *vs* 6. Also, the test on 18 *vs* 12 showed the greatest number of errors, and it is likewise the most dissimilar, as a whole, from the training situation. The two tests on 6 *vs* 4, and 9 *vs.* 13 fall in between these two extremes, both as to similarity to the training series and as to the number of errors made.

The indication, then, is that transfer of reaction, when it occurs, is on a relative basis, but that the transfer is confined to a limited range around the absolute size of the figures used in the training series. Beyond these limits, the transfer first becomes inaccurate and then breaks down.

Summary

An experiment was designed to test the dominance of relative and absolute cues in the animal's reaction. Reaction on the basis of relational as opposed to absolute cues was demonstrated for the rat in size discrimination.

Imperfection of this transfer on the basis of relation was noted in this as in other experiments. Tests were made to see what caused this imperfection of reaction. Three hypotheses were tested.

1. Normal random variation in performance was found to be an inadequate explanation.

2. Opposition of the relational cue by the absolute cues received from the stimuli presented during the training period is an inadequate explanation.

3. Resemblance of the situation as a whole in the test period to the situation as a whole in the training period adequately explained the imperfection of transfer of reaction on the basis of relational cues.

References

1. Bingham, H. C. Size and form perception in *Gallus domesticus*. *J. Anim. Behav.*, 1913, **3**, 65-113.
2. Coburn, C. A. The behavior of the crow, *Corvus americanus*, Aud. *J. Anim. Behav.*, 1914, **4**, 185-201.
3. Gayton, A. H. The discrimination of relative and absolute stimuli by albino rats. *J. Comp. Psychol.*, 1927, **7**, 93-105.
4. Gotz, W. Vergleichende Untersuchungen zur Psychologie der optischen Wahrnehmungsvorgänge. I. Experimentelle Untersuchungen zum Problem der Sehgrössenkonstanz beim Haushuhn. *Zsch. f. Psychol.*, 1926, **99**, 247-260.

5 HELSON, H Insight in the white rat. *J Exper. Psychol.*, 1927, **10**, 378-396

6 JOHNSON, H M Visual pattern discrimination in the vertebrates. *J. Anim Behav*, 1916, **6**, 169-188.

7 KINNAMAN, A. J Mental life of two Macacus rhesus monkeys in captivity *Amer J Psychol.*, 1902, **13**, 98-148, 173-218

8. KOHLER, W Gestalt psychology New York: Liveright, 1929. Pp x+403.

9. LASHLEY, K S Visual discrimination of size and form in the albino rat *J Anim Behav*, 1912, **2**, 310-331

10. ———. The mechanism of vision I A method for rapid analysis of pattern-vision in the rat *J Genet. Psychol.*, 1930, **37**, 453-460

11 PERKINS, F. T, & WHEELER, R H. Configurational learning in the goldfish *Comp. Psychol Monog.*, 1930, **7**, No. 1. Pp. 50

12 REVÉSZ, G Experiments on animal space perception *Brit J Psychol* (Gen Sect), 1924, **14**, 386-414

13. TAKEI, K. On visual discrimination and its learning with chickens *Jap J Psychol*, 1927, **2**, 32-87 (Cited from *Psychol. Abstr*, 1928, **2**, 552)

14. WARDEN, C J., & ROWLEY, J. B Discrimination of absolute versus relative brightness in the ring dove, *Turtur risorius* *J Comp Psychol*, 1929, **9**, 317-338

15. WASHBURN, M F, & ABBOTT, E Experiments on the brightness value of red for the light adapted eye of the rabbit *J. Anim. Behav*, 1912, **2**, 145-180.

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ÉTUDES SUR LE TRANSFERT DE LA RÉACTION I LES FACTEURS RELATIFS ET LES FACTEURS ABSOLUS DANS LA DISCRIMINATION DE LA GRANDEUR CHEZ LE RAT BLANC

(Résumé)

On a fait une expérience pour tester la dominance des suggestions relatives et absolues dans la réaction de l'animal La réaction sur la base des suggestions relatives opposés aux suggestions absolues a été montrée pour le rat dans la discrimination de la grandeur

On a noté l'imperfection de ce transfert sur la base de la relation dans cette expérience ainsi que dans d'autres expériences. On a fait des tests pour trouver la cause de cette imperfection de la réaction. On a testé trois hypothèses

1 Une variation normale au hasard dans le rendement ne s'est pas montree une explication suffisante

2 L'opposition de la suggestion relative par les suggestions absolues reçues des stimuli présentés pendant la période de l'entrainement ne suffit pas pour l'expliquer

3 La ressemblance de la situation entière dans la période de test à la situation entière dans la période de l'entrainement suffit pour expliquer l'imperfection du transfert de la réaction sur la base des suggestions relatives

GULLIKSEN

UNTERSUCHUNGEN AN DER ÜBERTRAGUNG DER REAKTION. I. RELATIVE VERSUS ABSOLUTE EINWIRKUNGEN AUF DIE GRÖSSENUNTERSCHEIDUNG (DISCRIMINATION OF SIZE) BEI WEISSEN RATTEN

(Referat)

Der Verfasser entwarf ein Experiment zur Untersuchung der Hervorragung von relativen und absoluten Weisungen (cues) bei der Reaktion des Tieres Es zeigte sich, dass die Ratte bei der Grossenunterscheidung auf der Basis relativer anstatt absoluter Weisungen reagierte Es wurde aber bemerkt, dass diese Uebertragung auf Basis der Beziehung (basis of relation) in dieser Untersuchung wie in anderen Untersuchungen nicht vollkommen war. Es wurden Versuche gemacht zur Bestimmung der Ursache dieser Unvollkommenheit der Reaktion Es wurden drei Hypothesen gepruft

1 Ein Erklarungsversuch durch normale zufallige Variation der Tatigkeit erwies sich als ungenugend.

2 Die Idee, dass der auf Beziehungen basierte Weisung durch absolute Weisungen, die von den wahrend der Periode der Einubung dargebotenen Reizen empfangen wurden, entgegengewirkt wird, ist ebenfalls eine ungenugende Erklarung

3. Die Aehnlichkeit der Gesamtlage wahrend der Versuchsperiode mit der Gesamtlage wahrend der Einubungsperiode erklart genugend die Unvollkommenheit der Uebertragung der Reaktion auf Basis der auf Beziehungen ruhenden Weisungen

GULLIKSEN

STUDIES ON THE CULTURAL DEVELOPMENT OF THE CHILD

Edited by A. R. Luria and L. S. Vygotski

III THE DEVELOPMENT OF VOLUNTARY ATTENTION IN THE CHILD*

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A. N. Leontiev

The problem of the nature and mechanism of voluntary attention and the general questions of the voluntary behavior of man belong to one of the least accessible fields of the science of psychology.

The difficulties associated with the problem of voluntary acts arise, undoubtedly, from the fact that the main principles upon which the scientific study of higher forms of behavior are built have not been sufficiently worked out.

The first important step towards the construction of a scientific theory of voluntary attention is made when we refuse to regard the higher forms of attention as immobile, completed phenomena, subject to direct research, and, instead of that, proceed to their genetic study.

The idea of development alone, taken as a methodological principle, cannot, of course, determine the direction to be taken by the research work. The conception of development may be interpreted variously. We may regard development either as the result of the unfolding of forces inherent in the nature of the given creature, or as the result of a concrete process of interaction of the organism and the environment. According to the point of view we choose, differences will be found in the comprehension of the phenomena studied, and, consequently, in the main method of research. Even in the latter case, however, when the development of the higher psychological functions is regarded as a result of interaction, there still remains a fundamental question—the question of the central factor determining this interaction.

If, on the one hand, we can take the genetic point of view as a sufficiently established one in contemporary psychology, on the other

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hand, the question of the principal factor lying at the basis of man's psychological development has been also decided in the main

In particular, and in connection with the development of voluntary behavior, the rôle of this factor, that is, the specific part played by the social environment of man, has more than once been indicated in psychology, and there exists a number of fully worked-out theories on this subject Blondel's theory of will and J Ribot's theory of voluntary attention are especially interesting in this connection Until lately, however, these theories had no place in the great psychological systems, and did not constitute an organic part of any one integral structure, which, creating this whole, would at the same time acquire significance as a part of the whole. In this respect the fate of Ribot's theory of attention is typical In present-day psychology this theory is persistently shown from one side only, that is, as a "motor" theory, while the other, and from our point of view, much more important side—bringing out the socio-genetic conception of voluntary attention—remains in the background. Obviously, it does not find a sufficiently wide response in present-day psychological thought.

The social nature of voluntary attention is constantly being emphasized, but this does not mean that attention is actually being examined from this point of view "Both voluntary and involuntary attention are the result of the dominant process, *of choice* between disturbing factors," says one of the most recent writers on this subject. If this choice is conditioned chiefly by *peripheral causes* (intensity of irritation) or internal organic causes, we speak of *involuntary attention* If this choice is conditioned chiefly by *central* causes, which are expressed, so to speak, in the routine work of associative nerve routes, we speak of *voluntary* attention

It is clear, then, that voluntary attention arose as the result of the development of social relations, and is the product of social connections and environment (4) [1]

Are the actual premises for the study of the mechanism of this important psychological function contained in this and similar assertions? To merely indicate the importance of social environment is not sufficient "The routine work of associative routes" is by no means the result of the specific influence of this environment The work of the central agent, the most complicated associative connections we discover in the higher animals, where voluntary attention

[1]The italics are Dobrinin's

does not exist and behavior is not influenced by social environment Here, the point is not the formal recognition of the important rôle of social factors, but, first of all, of discovering the interrelation of phenomena and of laying bare that concrete mechanism, on the basis of, and due to which, is formed the highest of activities regulating behavior

On the other hand, there is no doubt that until the main principles of development have been formulated, and the specific means of functioning, of these higher forms of behavior (which are subject, genetically, to social conditions) are discovered, the collision between the simplified mechanical-materialistic and idealistic points of view will also remain insuperable This collision creates contradictions which destroy the present-day psychological system[2] To remove the cause of these contradictions, we must lay bare the mechanisms of those qualitative, peculiarly human forms of behavior, which are created by social environment, unknown to the biological world; or, in other words, we must create a general theory of the social and historical development of behavior. Such a theory of social genesis ("the theory of cultural development") was first formulated and brought forward by L. S Vygotsky.[3] His theory forms the basis of the present experimental-psychological sketch The task we have set ourselves is twofold. on the one hand, it aims at providing, on the basis of the methods worked out by us, new experimental material for some general lines of this theory, and, on the other hand, to map out the route of its further development in the field of the study of voluntary behavior.

The problem of the voluntary regulation of behavior, the problem of voluntary acts, is often carefully avoided in materialistic psychology It is just in this problem that different philosophic systems collide, and it should be solved by materialistic science. For this reason, therefore, admitting its complexity, we apply ourselves to its solution to the utmost of our ability. In this lies the justification for this article, which claims least of all to be a finished and exhaustive study of the question, and assumes significance only in connection with the theory forming its basis

I

The simplest, primary acts have been fairly well studied in psy-

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[2]A detailed explanation of this is given by us in another place in a study of the problem of memory (6).

[3]See bibliography at the end of this article

chology. In this respect psychology is greatly indebted to physiology Thanks to the psychological researches conducted by Pavlov and Ukhtomsky on the work of the higher nerve centers, it has been possible to establish the main nervous mechanism lying at the foundation of the processes of the elementary regulation of behavior. This simplest kind of activity which organizes and regulates behavior and to which, in psychology, corresponds the conception of involuntary, primary attention, expresses itself with the help of the innate psychological mechanism and is wholly conditioned by external stimuli and their direct bearing on the particular state of the organism

The problem of voluntary attention presents a much greater difficulty to the research worker. In this higher form of regulation of behavior, the immediate degree of intensity, "newness" or affectogeneity of the active stimuli, are already not decisive factors. At the basis of this lie new and much more complicated mechanisms, which create a certain independence of behavior from its direct elementary stimulus The term "voluntary attention" seems to us to express correctly the peculiar nature of this higher form of regulating and organizing activity, indicating its two specific signs: first, its outward independence of direct factors, and, secondly, the presence of effort, which finds both its subjective and objective expression.

All regulation of behavior requires two orders of change, change of *direction* of behavior and change in the distribution of *force* The question of direction and behavior is that of the domination of one or another competing stimulus In the simplest cases it is decided by the respective strength of stimuli acting directly in their struggle for the common field of action What is meant when we speak of regulation of the distribution of energy is usually associated with the simplest factor of the continuation of behavior According to Sherrington, in spinal dogs the unconditional "scratch reflex," after prolonged action of the stimulus, exhausts its resources of energy and ceases. Only after a certain interval the necessary stock of energy is restored and the reflex appears again. In dogs which have not been deprived of the brain the activity of the reflex decreases at a much slower rate, since an additional stock of energy is mobilized in the higher centers This is, then, the simplest case of the regulation of the energy side of the process.

Both these forms of regulation are determined in the above examples, by peculiar situations: the direction of behavior lends itself directly to external situations, the necessary redistribution of energy

is conditioned either by the repetition of the action of the main stimulus or by the action of some stimulus co-existent with the main stimulus, what Ukhtomsky calls the "sub-dominant stimulus."

An entirely different condition obtains in more complex behavior. The behavior of a child, let us say, is fixed on a book which he is reading. The child's attention is distracted from reading by other stimuli: we stimulate the child to continue his reading, and he turns again to the book. Now let us study the following situation; the child is reading in conditions excluding the interference of outside stimuli. After a while, reading ceases, the first flush of energy for reading is exhausted. If the child is stimulated by promises of a reward, it will be possible to continue the process.

How does the regulation of behavior in the simple and rather artificial examples with the child differ from the regulation of which examples were given above? What, in both cases, determines the continuation of the reading? A special factor in this case is the stimulus which we create in addition. We promise the child a reward—that is not the repetition of the first main stimulus, the book, nor is it the direct increasing of this stimulus—the book does not increase in size nor become brighter, newer, or more interesting—we create a second new stimulus which determines the victory of the former. The relation of this second stimulus to the main center of agitation is qualitatively not unimportant, it is not a simple sub-dominant agitation, mechanically increasing the "dominant." Although it strengthens the primary direction of behavior, our second stimulus does not stand side by side with the first, it does not stand in relation to the general behavior of the child as simply coexistent, but as a means to an end. The regulation of behavior is realized in these examples by means of the second stimuli: such regulation we might call "instrumented regulation," as opposed to direct regulation, of which examples were given above.

Is there, in the latter examples of a child's behavior, a case illustrating what we call voluntary regulation of behavior and of voluntary attention? Yes—and no. Insofar as both series of stimuli are equally independent of the child, no; but, on the other hand, this regulation *is* "voluntary," from the point of view of the person influencing the child, the person who is controlling the stimulus which controls the behavior of the child. The process as a whole is here divided between two people, whose behavior is subjected to one general aim: one person reacts directly, and the other reacts in a direc-

tion of creating a series of stimuli intended to react on the first. Let us now take both these forms of behavior united in one person: the child reacts to the present situation, not directly, in his main line of behavior, but in the direction of attracting an additional series of stimuli organizing his own behavior. This would be a case of voluntary regulation of behavior. The Chinese postman delivering an urgent telegram acts in just the same way, he organizes his own behavior, creating for himself additional stimuli. He hangs a number of objects—a piece of coal, a pen, and some pepper on the end of a short rod. This he keeps before his eyes on the road. This will remind him that he must fly like a bird, run as if he was stepping over hot coals or had burnt himself with pepper.

As he goes on his way, something unusual going on in the street, or tempting goods displayed in the shops, or the prospect of a nice rest in the shade of the trees might distract him from his business, and might destroy and disorganize his behavior. The artificial "stimuli" or "signs" created by him serve to direct his attention anew to his real task.[4]

The examples given suggest an outline of the structure of the higher forms of regulation of behavior; voluntary regulation appears to us as instrumented regulation, "instrumental," realized by attracting means as a second series of stimuli. The controlling of behavior becomes possible only by the mastering of stimuli: this condition is justified in relation to our own behavior (Vygotsky). To render one's own behavior voluntary means to master it, subject, of course, to its own natural laws. The sensation of effort, which sometimes accompanies our voluntary acts, and particularly all efforts of voluntary attention, creating the illusion of voluntary action, in the specific meaning of the word (that is, in the sense of freedom of action, carried out by means of a special psychic force) is explained through this peculiar, double structure of voluntary acts, which creates the mobilization of energy.

Thus the sensation of effort appears to be no other than a sensa-

[4]It is possible that these special stimuli-signs, still in use in some Chinese provinces have already lost their meaning; there is no doubt, however, that originally their use was dictated by necessity. Describing the Indian tribe of Dajibis, Richardson says: "We became convinced, after experiments, that in spite of high rewards offered for the prompt delivery of a letter, it was impossible to trust them to do it. The slightest difficulty, the prospect of a carouse or of a tasty roast dinner, or the sudden appearance of a desire to visit a friend, was sufficient to make them postpone the delivery of a letter for an indefinite time" [quoted from Lubbock (8, p. 454)].

tion which naturally accompanies "the awakening and unfolding of the secondary tendency, which arises in connection with the first and increases its energy" (Janet).

The conception unfolded by us of voluntary regulation of behavior, is that working hypothesis which lies at the basis of the present inquiry, and which determines its central task to trace the route of development of the outward forms of behavior in children

II

The history of voluntary attention begins when the first elementary social stimuli make their appearance in behavior. Already the tribal hunts which were the earliest instances of collectivism in man entailed the necessity of controlling the attention of the hunting group: this was an indispensable condition for organized hunting. The function of the leader here was to submit the behavior of the collective to a common end, which meant that first of all the aim had to be *indicated,* that is, attention had to be drawn to it. That is exactly what we do in our first attempts to influence the child: we begin with indication, that is, with attracting his attention. Here there is as yet no new and higher structure of the act of attention: the reaction of the child remains natural, directly conditioned by the external stimuli acting upon it, this kind of reaction, as is well-known, can be found also in the higher animals.[5]

The process of attracting attention, however, the act of indicating, already bears its own peculiar characteristics, this act is social in its essentials. In some animals we meet with activities reminiscent of indicating but their nature proves to be quite different. Birds collecting in flocks select sentries, their duty seems to be to warn the rest when danger is near. If we examine the behavior of the sentry-birds, we become convinced that these possess no special acts of behavior for this purpose. When a bird is startled it shrieks and starts up with a great flapping of wings, that is, it acts in the same way as the rest of the birds act at its signal. That is why we never see, among animals, sentries placed outside the field where the flock may observe it. Such a disposition of sentries, which would best secure the safety of the flock (or herd), is not possible among animals, since it presupposes the existence in the sentry-bird of such special action as would regulate the behavior of the flock. Even as regards the most complicated forms of instinctive reactions, we are not in a

[5]See Darwin (3, p. 49).

position to discover such specially instrumented actions. the common crane, for instance, before returning to the place it has left, first sends a scout this scout, however, does not possess any specific action for its work

Thus, with the exception, perhaps, of only a few, much disputed cases, where the so-called "warnings" are issued by thoroughbred hounds subjected for generations to the influence of man, we do not meet in the animal world any special forms of action having as their sole and special end the mastery of behavior of other individuals by attracting their attention

The history of one man's mastery over the regulation of behavior of another repeats in many points the history of his mastery over tools It presupposes a change in the structure of behavior, which turns behavior directed to an end into behavior directed circuitously The selection and production of instruments or tools is supplanted here by the creation of a series of stimuli, which, through the object of influence, determine the achievement of the end In this sense these stimuli prove to possess an instrumental function At first, their indispensable factor is their intensity, but in the process of their development and differentiation they become specialized and acquire the character of a conventional *sign* in this way *indication* is born, as a sign of attention It is exactly the indication (gesture, speech, etc) which conditions, in the primary history of behavior, the development of the higher forms of attention As the researches of L S Vygotsky show, it is that catalytic factor which modifies the inter-central relations and, destroying the even balance of the situation, causes the activation of corresponding processes (16, 19)

In some of our experiments with instrumented memorizing, and in that series where we suggested to the child that he should remember a number of words with the help of one complicated picture, we also had an opportunity to observe this function of the indicative gesture, the subjects upon which we experimented were mentally backward children who, when turning their attention to one or another detail of the picture, quite spontaneously used the indicative gesture as a means of distinguishing the given detail from the general whole Figure I shows a cutting from a film taken of this experiment

The regulation of attention presumes, as we have already remarked, a change of a double nature the change in the direction of behavior and also in the distribution of force, that is, an increase in the duration of the act Attention is directed to a definite object and remains

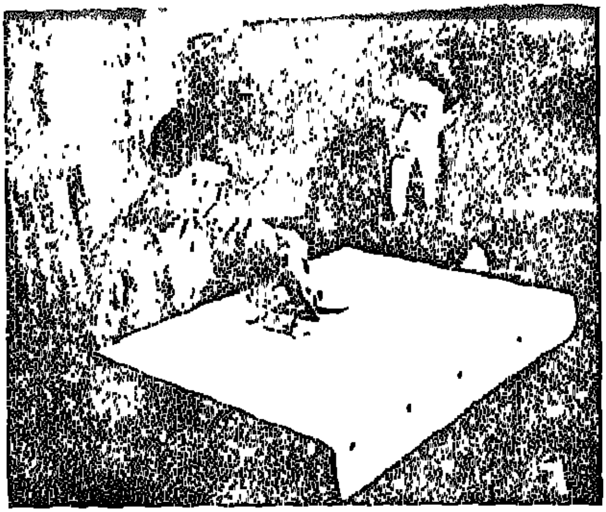


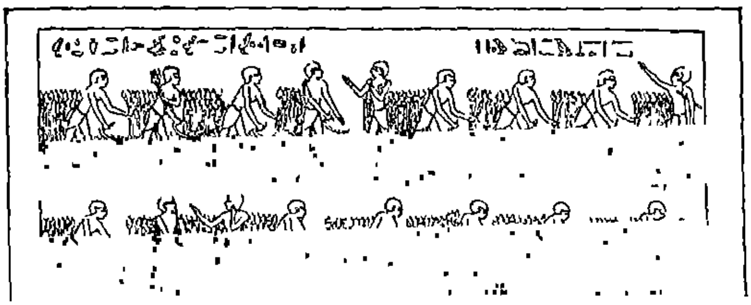
FIGURE 1

fixed on it for some time, this "action of the will directed to a certain aim and expressed in attention" is an indispensable condition for all kinds of ordered work and is all the more necessary as the action becomes less attractive "A savage is passionately devoted to the chase, war and play he loves the unexpected, the unknown, the accidental, in whatever form it appears, he does not know what persistent labor is, or if he does, he treats it with contempt Love of labor is of much more complicated origin, developing along with the progress of civilization, and labor, as is well-known, is simply the concrete expression of attention"

Half-civilized tribes feel a certain repulsion to ordered labor. Darwin once asked the Guaches why they did not work but were given over to drunkenness, play, and thieving "Because the days last too long," was the reply The life of a primitive man, says Herbert Spencer, is almost entirely devoted to the tracking of animals, birds, and fish, which provide him with pleasant excitement. Among civilized peoples, the hunt, although it serves as a form of entertainment, is far from being widespread and is only temporary But, whereas in primitive man the power of uninterrupted, persistent attention was very poorly developed, with us it has attained a very considerable degree (16, p 55).

Thus, the transition of the savage from capricious and fitful dissipation of energy to the specific, systematic, and organized labor of man, signifies, as we see, the transition to a higher form of activity of attention This fact holds a tremendous significance for psychology. The task before research workers now is to show how the voluntary attention of man developed together with his working activity Of course, any detailed historical or sociological analysis of this process would demand special research. We will here confine ourselves to the indication of two series of historical facts of particular interest to us in connection with the conception of attention described above

It is well known that the transition to regular labor is usually achieved with its division At first only part of the tribe, the women or the slaves, were obliged to do *systematic work* as a punishment. On the other hand, we know what a tremendous part in the labor processes of primitive man was taken by external organizing environment—the activities of foremen, the ceremony of beginning and ending the work, the rhythmic musical accompaniment to labor It may be admitted that this labor activity, achieved under the influence of direct compulsion, could be called labor only in the sense that we apply the word to the "labor" of animals. But the very necessity of compulsion arouses the organizer of these living instruments to



Египетские крестьяне на барщине жнущие в такт овес под звуки флейты и с песнями. В каждом ряду человек, отбивающий такт; справа наверху надсмотрщик. (Из гиметского музея, по Vigouroux, Diction. de la Bible)

FIGURE 2

EGYPTIAN PEASANTS REAPING OATS FOLLOWING THE SOUNDS OF THE FLUTE

In each row there is a man marking the time. (From the Guimetian Museum, Vigouroux, Diction de la Bible)

the creation of special stimuli regulating their behavior. The originally direct and simple stimuli undoubtedly speedily gave way to conventional stimuli; along with this, and what is most important, the stimuli formerly used on others could be adapted to the first person. Signals given by the foremen, the rhythmic sounds of a drum, working songs—these created the center around which the labor activities of the primitive man were built up

"The savage avoided work not as a *physical* but as a *spiritual* effort," says Schurtz, that is, he avoided or rather was not capable of straining his attention These means of organizing and regulating work were directed first of all to the organization of attention · their aim was to communicate to the work the necessary direction and continuance "Working songs are important documents, giving evidence of the half-conscious self-education of humanity" (17, Vol 2, Chap. 6) It might be said that first of all they are evidences of the education of higher forms of attention, indispensable for the further unfolding of labor activity.

The transition from the organization of attention of others to the creation of stimuli organizing their own attention—this is the route marked out in the history of development of voluntary attention. Mastering stimulation, man masters his own behavior, in submitting himself to its natural laws he in this way subjects it to himself and in this sense turns it into voluntary behavior We see that at the foundations of this process lies the general process of the socialization of man. The beginning of collective labor and economic activities, which signify that humanity has entered the historical phase of its development—this is the chief condition for the appearance of higher forms of behavior. Here we have an extremely complicated process of the double relation of interchange between the individual and his social comrades. In this process, in J. M. Baldwin's terminology "the *social* element *projecting itself* into the personality forms the 'subjective,' which by a return movement is transmitted anew to other people and thus becomes 'ejective' "[6]

Therefore, voluntary attention is a later and extremely complicated product of prolonged development Its root lies at the very earliest stages of the history of human society It develops, says Ribot, on the basis of involuntary attention, onto which it seems

[6]See (1, Vol 1, Chap. 1, Vol. 2, Chap 14, 2, Vol 2). We here use only the terminology of this author, leaving his general conception of development aside

to be artificially grafted and from which it derives the conditions of its existence, as branches grafted to a tree trunk feed on its sap.

Primary involuntary attention, influenced by the employment of "psychological instruments" which are first directed to surrounding people and subsequently to itself, turns into voluntary attention These "psychological instruments," originally simple, unconventional, intense stimuli, differ from labor instruments in that they are directed to the mastery of man's behavior. The process of their inception and development is also the process of their acquiring a conventional meaning, they are the "instrument-signs," and in this lies their specific character When they are turned on oneself they may become internal, and thus behavior is free from external stimuli-signs which regulate it

The place of the external sign is taken by internal psychological elements, acquiring a *significative* meaning. Such applied-to-oneself, instrumental, significative regulation of behavior is what we call voluntary attention

III

In the behavior of a very young child, just as in that of a primitive man, we are not in a position to discover acts of voluntary behavior It is only at an advanced stage of individual psychological development that voluntary attention begins to take on that central importance which it possesses in the general system of behavior of the cultured adult This most important psychological function of a modern man is the product of his social and historical development It was born in the primitive savage out of the process of his socialization, being a product of labor activity, it is at the same time an indispensable condition for it In this sense, this function has developed historically, and not biologically "Each subsequent generation," says Ribot, "*learns* voluntary attention from the preceding one" Thus the development of voluntary attention means, first of all, that the child acquires a series of *habits of behavior*

Through the mastery by surrounding people of its attention, the child masters, at first imitatively, the attention of the people surrounding it While stimulating others, the child learns to stimulate itself At first, the external stimuli—means which the the child organizes in order to master its own behavior, are replaced, in the process of their development, by internal stimuli as they "grow in" external stimuli turn primary attention into significative, and attention becomes voluntary

The business of experimental-psychological research now is to show how, under laboratory conditions, this process takes place, that is, to bring it within closer range and make it accessible for direct study.

The methods which we have worked out with this end in view are as follows: the child to be experimented on was placed in conditions of such activity as required active concentration of attention; along with this, the child was offered a number of external objects ("second series of stimuli") which might serve as "psychological means" for this activity. For instance, during the experiments, which took the form of play, the child was given the opportunity to "win" a certain prize. In order to create such activity, we used the old children's game "Don't say white or black, don't answer yes or no (having, of course, slightly altered it). The whole experiment consisted usually of three or four series and was carried out in the following way:

In each series the child was given, according to a special formula, eighteen questions, out of which seven concerned the color of things ("What color is . . ?") The instructions demanded that the child should answer each question promptly and in one word, especially in the case of colors—simply the name of the color. The first series which were, on the one hand, of a controlling and, on the other, of a training character, passed without any additional limitations. In the second series only we began the "play" itself, introducing, as a condition for winning, two new demands, the child won only in case he answered our questions, first, without repeating twice the name of one and the same color, and, second, if he did not name one of the "forbidden" colors. The third series differed from the first only insofar as the child was given nine colored cards as means of assistance ("they must help you to win").

Having placed the cards before them, the children, when answering questions, usually picked out and then placed on one side cards of the color named or turned them over, and at the same time fixed the "forbidden" colors. As if introducing into the process, in this way, a new series of external additional stimuli-means, the child solved the task set him, turning his behavior into indirect, instrumented; his perception and reactions were realized through these interposed signs, which here took the place of the refracting glass of which Revault d'Allones,[7] speaks in his work. These cards were used before the beginning of the experiment in order to find out

[7]See (14, p. 34). See also (15, pp. 846-919).

whether the child knew the names of colors The fourth series was built up similarly to the third, and was carried out in cases where the child did not show evidence of having found out how to use the cards or did so only towards the end of the experiment. Before and after each series it was ascertained by means of special questions how far the child mastered and remembered our instructions.

All four series of questions in our lists were practically analogous to each other, containing an equal number of equally distributed "critical questions" about colors and presenting certain obstacles to the correct solution of the tasks In a number of cases they were even provocative of error, but still allowed of fulfilling all the conditions of the experiments and evoking thoughtful answers

In the experiments we tried to link our questions together and ask in the form of—"Tell me!" and "What do you think?" speaking in an ordinary conversational tone. In this way the questions contained in the list, although they were in their exact form and order, a necessary element of our "experiment-play conversation" with children, did not compose its only contents

The series we offered contained the following questions.

First series: (without "forbidden" names) (1) Can you draw? (2) What color is your handkerchief? (3) Did you ever go in the tram? (4) What color is the tram? (5) Do you want to study? (6) Were you ever at a meeting? (7) Do you like reading? (8) What color is the paper? (9) and pencils? (10) Do you play with toys? (11) Have you seen the sea? (12) What color is the sea? (13) Did you ever listen to music? (14) Have you seen vegetables growing? (15) What color are cucumbers? (16) Do you like dogs? (17) What color are cats? (18) What does one do with a saw?

Second series (green and yellow are chosen as "forbidden" colors) (1) Have you a playmate? (2) What color is your shirt? (3) Did you ever go in a train? (4) What color are the railway-carriages? (5) Do you want to be big? (6) Were you ever at the theatre? (7) Do you like to play in the room? (8) What color is the floor (generally)? (9) And the walls? (10) Can you write? (11) Have you seen lilac? (12) What color is lilac? (13) Do you like sweet things? (14) Were you ever in the country? (15) What colors can leaves be? (16) Can you swim? (17) What is your favorite color? (18) What does one do with a pencil?

Third series. (Forbidden colors blue and red) (1) Do you some-

times go for walks in the streets? (2) What colors are the houses? (3) Does the sun shine brightly? (4) What color is the sky? (5) Do you like candy? (6) Have you seen roses? (7) Do you like vegetables? (8) What color are tomatoes? (9) and what color are exercise-books? (10) Have you any toys? (11) Do you play ball? (12) What colors are balls? (13) Do you live in the town? (14) Did you see the demonstration? (15) What color are flags? (16) Have you a book? (17) What color is the book-cover? (18) When does it get dark?

Fourth series: (Forbidden colors black and white) (1) Do you go to school? (2) What color is ink? (3) Do you want to be a soldier? (4) What color are boots? (5) Do you like to play? (6) Have you ever seen a lion? (7) Do you know what underclothes (linen) are? (8) What color are collars? (9) and bags? (10) Are you a good pupil? (11) Do you like pears? (12) What color are apples? (13) Were you ever in a hospital? (14) Did you see the doctor? (15) What color are overalls? (16) Do you go for walks in the garden? (17) What colors are paints? (18) When does it snow?

Although these series of questions seem to us, a priori, to be of practically equal difficulty, we changed their order in certain cases (2nd, 3rd, and 4th series).

The cards we used were black, white, red, blue, yellow, green, purple (lilac), brown, and gray.

As the experiments showed, the tasks set the children were, in cases where they were to be carried out without the help of the cards, difficult enough even for adult subjects On the other hand, children of school age experienced no difficulty in finding out how to use the cards, and had usually learned to use them in the first (III) series with cards. In cases where the method of using the cards was not discovered by the child itself in Series III, we told him and carried out Series IV with him also In summing up, we have generally taken account of the data of this last series.

Not counting trial experiments, 30 subjects were experimented upon They included children of below school age and of school age, and adults, numbers being practically equal in all the groups. The comparatively small number of experiments made, owing to the fact that experiments with children are a comparatively difficult matter, scarcely permits us to insist on the exactitude of the average figures obtained, but they are sufficient for the immediate purposes of our inquiry

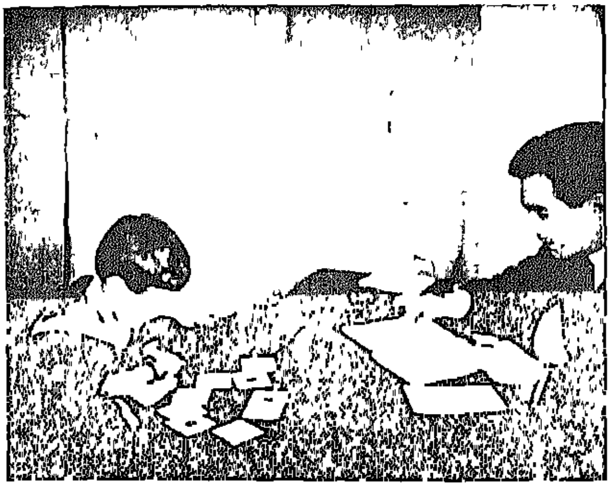


FIGURE 3

Some of our experiments were filmed and separate sections of these are shown in Figure 3

It must be remarked that the experiments were usually carried out in a very natural and lively way We noticed later that very often, when playing with others, the children faithfully reproduced the conditions of our experiments, substituting colored paper for our cards and repeating more or less accurately our questions This circumstance afforded us considerable difficulty in getting children for the experiment, since under these conditions we were prevented from using children belonging to the same group

If we add up the average number of wrong answers given during experiments with different groups of subjects (see Table 1), the sharp difference between the groups will become evident

From the above it is clear that children of below school age answered a little more than half of the "critical" questions without following the rules of the game Children of preschool age are very easily distracted from their main task by the subject of the question, and easily give way to "provocation," sometimes not even noticing their mistakes For the third series (with cards), we have almost the same figures as for the second, the difference between them being expressed by the insignificant figure 0 3 As a rule, children of

preschool age are unable to discover by themselves how to use the cards. Even after they have been told (Series IV) children, while handling the cards, are not capable of using them in fulfilling the task set them. We discover here, as well as in experiments with instrumented memorization, a point characteristic of the preschool age: the almost complete incapability of using external stimuli as an auxiliary means for organizing one's own behavior.

In some instances we did not limit ourselves to the simple communication of the method, but first (before Series IV) allowed other children who had fully mastered ways of using the cards to demonstrate them to our subjects. Even then the results only showed external imitation in the case of children of preschool age (subjects 14 and 15). This is illustrated by the following excerpt from minutes.

Experiment No. 11

Subject—5 years of age

Series IV. "Forbidden" colors, blue and red

Method of using the cards was shown by other children who had been previously experimented upon.

2	What color are houses?	*Red* (without looking at forbidden colors)
3	Is the sun shining brightly?	Yes
4	What color is the sky?	White (without looking at card, but after replying, searches for white card—"Here it is!" Picks it up and keeps it in his hand)
8	What colors are tomatoes?	Red (throws a glance at cards)
9	And what color are exercise books?	White—like this! (pointing to white card)
12	What color are balls?	White—(looking at card)
13	Do you live in the town?	No, etc., etc.
	Do you think *you* have won?	"Don't know—yes."
	What must you not do if you want to win?	"Mustn't say red or blue."
	And what else?	"Mustn't say the same word twice."

In fact, the cards not only do not help the child of preschool age, they actually hinder him from carrying out his task. On the examples given above the repeated reactions "white" arise from the fact that the child fixes his attention on the white card. The cards take a certain part in his behavior, but this part is absolutely different from that taken in the case of the school child. These secondary

TABLE 1

Group	Age	No	Number of wrong answers In Series II	In Series III or IV	Difference between Series II and III
Below school age	5-6	7	3.9	3.6	0.3
School age younger group	8-9	7	3.3	1.5	1.8
School age older group	10-13	8	3.1	0.3	2.8
School age, average	8-13	15	3.2	0.9	2.3
Adults	22-27	8	1.4	0.6	0.8

stimuli only co-exist with the main stimuli, instrumental functions are not inherent in them and their part in the process is of quite an accidental nature. Still there is no doubt that in children of preschool age we sometimes meet with forms of behavior which might serve as premises for the development of the instrumental employment of external signs. From this point of view certain cases registered (subjects 10 and 11) are of special interest. In these cases, the child, after we had suggested to him that he use the cards in carrying out his task ("Take the cards, they will help you to win"), searched for the forbidden colors and put all such cards out of his sight, as if trying to prevent himself from naming them. One operation is substituted by another: the child in our example acts in the same way as an Australian or African savage might act in freeing himself from a dangerous man by destroying his image or symbol. The "magical" nature of the operation of putting away dangerous colors is, in the case of the child of preschool age, emphasized by the circumstance that the child thus limited himself to this and pays no further attention to the cards. This circumstance is of special interest to us, since, although in nature it is quite different, it externally reminds us of an abbreviation of the method of using the cards by adults, and also because it clears up the origin of one of the methods to which school children have resource when they want to carry out their task.

This "magical" attitude toward the means is still more clearly illustrated by our subject No. 17 (7, 8). This subject exhibited in

the third series all the cards without any order at all and as a result gave several wrong answers. Before trying the fourth series, in order to give the subjects some idea of the method of using the cards, we asked him: "Did the cards help you?" "Yes." "And what should you do so as to make the cards help you still more?" "Make a house with them." The child at once began to build a house with the cards, again without separating the forbidden colors "And how do you think they will help you?" "I don't know." "Well, perhaps you can do yet another thing with them so that they will help you still more?" "Put them in a circle," the child guessed. At last, after a few more suggestions the subject discovered the proper method and in the fourth series made no mistake.

Comparing the figures obtained from the experiments on children of preschool age with those obtained from children of school age (see Table 1), we notice a very slight reduction in the number of wrong answers in the second series, whereas the number of mistakes in the third series falls sharply. This is particularly noticeable in the case of the group of older children where the difference between the figures of Series II and III reaches a maximum of 2 8. We find a direct explanation of this point in our experiments. At school age, as we have seen in the data of the investigations on the development of memory, children begin to use the external "means-stimuli" and thereby considerably increase the effect of their psychological acts.

The behavior of a child of school age remains natural and does not differ greatly from that of a younger child In our experiments, in fact, we obtained in the second series figures quite near to each other, 3.9, 3.3, and 3.1 The number of wrong answers in cases when the operation remained direct decreases slowly with the growth of the child, but it is sufficient to allow of his equipping himself with the means accessible to him for the mastery of his behavior, as the effectiveness of his psychological acts increases speedily, a tremendous change takes place in the sphere of his psychological possibilities

The methods of using the cards can be reduced, in spite of their apparent variety, to two different types First comes the case when the child puts out of his range of vision cards of forbidden colors, exhibits the remainder, and, as he answers the questions, places on one side the cards of the already named colors. This is the least perfect and at the same time the earliest method used. The card here serves more as a memory sign than as an attention sign: its

function is only to register the named color. At the beginning of the experiment, children often do not turn to the cards before they answer the question about color, and only after it is named search among the cards, turn over, move, or put away the named one (see Report 3) This operation is carried out, as we see, with the idea of registering their reaction It is undoubtedly the simplest act of memorization with the help of external means It is only later that the conditions of the experiment bestow a new function on the card Before naming the color the child must necessarily make a selection with the help of the cards. It makes no difference whether the child has within his field of vision a series of so-far-unused cards, or whether he will get his bearings by the color already named to him; in both cases the cards will be interposed in the process, and will serve as a means of regulating his acts Actually, the separation of the used cards without putting them out of sight, for instance, by placing one of them in another row, presupposes the same subsequent operation, as is required by the exhibition of the forbidden colors, which is met with in the second type of employment of cards The preliminary putting-out-of-sight of forbidden colors, which is a distinguishing characteristic of the first method of using cards, does not yet lead to the "simulation" of an act, to the complete substitution of one operation by another, it represents merely a step in that direction. It is explained partly by the greater simplicity of the operation of mastering memory and partly by that "magical" attitude to means, which is constantly met with in children[8] and which we have already noticed in the given situation with the children of preschool age experimented upon.

Material gathered in the course of experimental research on instrumented memory, attention, and arithmetical operations shows that the part played by external means of behavior is especially important in children of school age[9] As to children of the earliest school age, we might even speak of a peculiar "hyperfunctioning" of external means which they have just begun to master Experiments

[8]See (13)

[9]In our work we were able to register (in subject No. 16) an instance of spontaneous turning of a child of school age in Series II (without cards) to colored objects among his surroundings with the idea of using them to assist him in his task, in this series the subject gave only two wrong answers altogether and in the third series none We have observed analogous instances in our experiments with indirect memory

made by L. S Vygotski and A. R. Luria (9) are in this respect extremely illustrative They suggested to the children that in order to remember a number of figures they should somehow record them, for which purpose they placed at the disposal of the children different objects such as paper, thin cord, and various small articles, including hunters' shot. The children of early school age as a rule tried to build up figures to be remembered out of the given objects.

REPORT NO 3

December 1, 1928

The case of Nastya D, 13 years old

SERIES II (with forbidden colors)

(Forbidden colors—*green* and *yellow*)

1 Have you playmates?	Yes
2. What color is your blouse?	Gray.
3. Have you been in a train?	Yes.
4 What color are railway carriages?	Gray (notices that she has repeated the same color twice laughs).
5 Do you want to be a big girl?	Yes.
6. Were you ever in a theatre?	Yes.
7. Do you like to play in the room?	Yes
8 What color is the floor?	Gray . . again—I repeated it
9 And the walls?	White
10 Can you write?	Yes.
11. Have you seen lilac?	Yes
12 What color is lilac?	Lilac color.
13. Do you like sweets?	Yes
14. Were you ever in the country?	Yes.
15 And what color were the leaves?	Green—no, shouldn't have said green—brown, red sometimes.
16 Can you swim?	Yes
17. What is your favorite color?	Yellow! I can't! (throws up hands behind the head)
18. What do you do with a pencil?	Write
What do you think, did you win or lose?	Lost.
What should you not have said?	Green and yellow.
And what else?	Shouldn't repeat (4 mistakes)

SERIES III (with cards)

(Forbidden colors *blue* and *red*)

The subject puts on one side cards of forbidden colors, and spreads out the remainder in a row before him

1. Do you go for walks in the street?	Yes
2 What color are the houses?	Gray (after answering looked at the cards and turned over the gray one)
3 Is the sun shining brightly?	Brightly.
4 What color is the sky?	White (first looks at card and then turns it over)
5. Do you like candy?	Yes
6 Have you seen a rose?	Yes
7 Do you like vegetables?	Yes.
8 What color are tomatoes?	Green (turns over card)
9. And exercise books?	Yellow (turns over card)
10 Have you any toys?	No
11. Do you play ball?	Yes.
12 And what color are balls?	Gray (without glancing at cards, after answering glances and notices mistake)
13. Do you live in the town?	Yes
14 Did you see the demonstration?	Yes
15 What color are flags?	Black (first looks at cards and then turns one over)
16 Have you any books?	Yes
17 What colors are their covers?	Lilac (turning over card)
18. When does it get dark?	At night
	(1 mistake)

Thus, in spite of the obvious inexpediency of using the method under the circumstances given, instead of, for instance, putting aside two grains of shot or two torn-up bits of paper, the children tried to form figures out of the extremely inconvenient grains of shot, which rolled all over the table As may well be imagined, much material and time was wasted by them The children of preschool age, who had not yet mastered the system of figures, behaved quite differently They chose a more economical method from the point of view of time and energy, acting just as a modern adult might who had already got over the first phase, when the external methods adopted have the greatest power over one.

In our experiments we had the opportunity of observing closely

this over-exaggerated rôle of external mediums. In a number of cases, in children of early school age, we met with replies which were irreproachable from the point of view of conforming to instructions, but were at the same time quite senseless. The child, in these cases, worked strictly by the cards, and named colors irrespective of the subject of the question. This "formalism," which is peculiar to children and throws them completely under the influence of the method assimilated, is also met with in the development of arithmetical operations. It is a well-known fact that the slightest change in the position of figures, in the actual writing of them, is sufficient to render the child incapable of even the simplest arithmetical action (Thorndike). Probably it is just this phase of the domination of external psychological mediums, through which the development of the higher instrumented, "significative" acts of behavior pass, that reveals itself in the history of the cultural development of humanity, in those numerous and extremely carefully worked-out systems of external methods of behavior which compose a typical feature of primitive society.

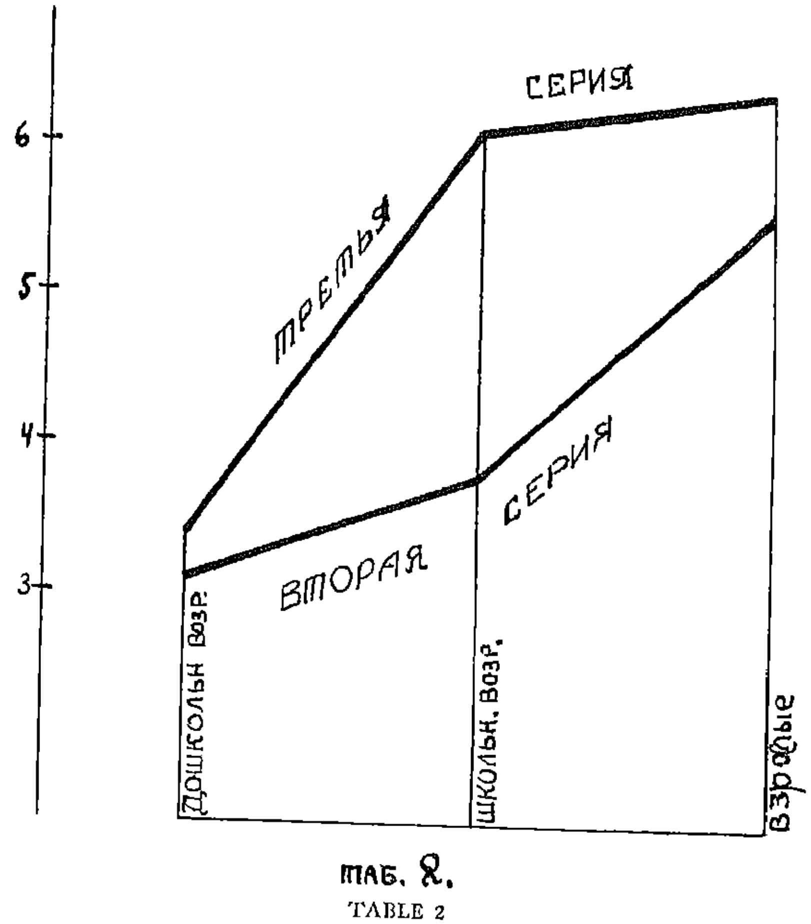
If we turn now to the figures illustrating the behavior of adult subjects, we discover a new and peculiar relation between the indices of our main series. Comparing these indices with the figures obtained with children of school age, we see that the difference existing between them does not concern the third series with cards, as was the case with the transition from preschool age to school age but is determined by the data in the second series. In this series we notice a distinct falling-off in the number of wrong answers given by adults

The general change in the coefficients obtained upon various groups of cases is illustrated in Table 2 Here the positive data are given by graphs showing not the number of wrong, but the number of right, answers, that is, the total number of answers to critical questions minus the number of answers not corresponding to the demands of the instructions.

The curves of development shown on the above table are very similar to the corresponding curves obtained in a course of experiments on instrumented memory Like the latter, they approach each other in their extremities, forming in their outline something like a parallelogram.

Therefore, quantitative characteristics obtained in our experiments indicate three principal stages of the development of instrumented behavior. First of all (preschool age), the stage of natural directed

acts At this stage of development the child is not capable of mastering his behavior with the assistance of the organization of special stimuli-means. The introduction into the operation of a number of cards, which might help the child in his task, does not increase to any considerable extent the effectiveness of this operation. The child proves incapable of their functional use Although they take the part of stimuli in his behavior, they do not acquire an instrumental function The next stage of development is characterized by a sharp difference in the indices in both of the main series.



ТАБ. 2.

TABLE 2

The introduction of cards, used by the child, as a system of auxiliary external stimuli-means, raises the effectiveness of his acts considerably. This is the stage of predominance of the external sign—the psychological instrument in the stimuli acting from without. We see at last that, as regards adult cases, the difference between the indices of both series is smoothed over again and their coefficients become more nearly equal, but now on a new and higher basis. This does not mean that the behavior of adults becomes again direct natural behavior. At this higher stage of development, behavior remains instrumented. At the same time the second series of stimuli-means gets emancipated from primary external forms. What takes place is what we here call the process of "ingrowing" of the external means: the external sign turns into an internal one. This is how the external forms of human behavior—instrumented, significative behavior—develop.

This theory of "ingrowing," formulated in the course of our study of the development of memory, is provided with some new proofs in the experimental material of our present inquiry. Among the many different methods of using cards, two, chiefly used by adults, are deserving of special attention. First of all, the case of employing cards to fulfil only one of the conditions of the task set. Some subjects limited themselves to the exhibition of the forbidden colors, while the other cards remained outside their range of vision. Thus, the operation is divided into two parts, one taking place without the help of external means, and the other with the assistance of the cards. This way of using the cards is met with twice: in the case of children of preschool age, but only in one instance (subject No. 11), and of some adults. It is probably due to absolutely different causes. In the first case, it is no more than an embryonic form, out of which the respective method begins to develop. With respect to the adults, it is much more complicated. Can we actually admit that one side of the operation here remains natural and direct, while the other side bears an obviously instrumented character? From our point of view such a presumption is scarcely possible, since, on one hand, we cannot discover any difference in the number of mistakes of a corresponding type, and, on the other hand, it is scarcely possible that an integral process should have a double structure. There is no doubt that we have here a case of the transformation of one of two series of external signs into internal signs, similar to that which we can clearly observe in the development of the counting operation,

where the carrying-out of a complicated arithmetical action presupposes a number of intermediary actions completed mentally Even in the simple operation of adding up a number of figures, it usually happens that the child must "carry in his head" higher quantities

These quantities, at first noted over the higher row with the help of figures and dots, very soon lose their external graphic signs and are substituted by internal signs It is obvious that the process analogous to this operation, performed simultaneously with the help of both the external and internal signs, takes place in the cases where cards are partially used.

The second form of incomplete use of external means is much more interesting. This is again met with most frequently among adults In this case all the cards are exhibited, while the usually forbidden colors prove to be the last in the row, or are placed in the center The subject answers the questions while looking at the cards but does not touch them One of our subjects, No. 2, was asked after the experiment whether the cards had helped or not: "They helped, of course, I looked at them and saw which I could mention and which not." This reply indicates clearly the essentials of the methods used by her. The means by which the task is solved seems here to assume a double form While remaining external, it already becomes half internal. The card, an external object, continues to exist as a card, but becomes a means only as the sign into which it is transformed with the help of the internal sign. The external removal of the cards in the group of "forbidden" colors, which we observed in other, simpler cases, was carried on here "in the head" The subject, mentally marking the cards of the colors named, imparted in this way a certain meaning to the cards, that is, transformed them into signs Thus, the process has here a sharply defined internal character and it is only supported by cards. It is clear from this that it keeps the same structure which it possessed in those cases when the operation was carried out entirely with the help of external stimuli-signs

We are inclined to ascribe a particular importance to these observations because they give new proofs to the theory of the significative nature of external intellectual processes, and along with this allow us to outline in still greater detail the transition from externally instrumented operations, accomplished with the assistance of internal signs.

IV

Placing on one side the process of development of attention in the child to the stage when it becomes instrumented, and on the other side the later process of the development of higher, significative forms of attention, we see that they are absolutely different in type. Biological development is replaced by development which we might call historical It consists in this—that the child, under the influence of its social and cultural experience, masters a number of methods of behavior, which transform his primitive, psychological acts into higher acts of new and complex structure This structure is characterized by the presence of secondary stimuli-means, which in the form of internal or external stimuli are interposed in the process.

The development of voluntary attention only repeats the development of other higher psychological functions; it becomes voluntary, turning from signal to significative. That system of social relations into which man steps at the dawn of his historical existence, and which forms for him a new environment unknown to the biological world, a social environment, that system determines the particular path of his psychological development.

Equipping himself anew for the struggle with nature, man places between himself and the physical objects of his operations, the tools which he has produced, by influencing nature with his tools he changes his own nature. The use of the tools creates a new series of labor processes, a new series of conditions of existence for man. These demand from him new actions and new forms of activity, and call for the redistribution of his physical possibilities, changing his skeletal, muscular, and nervous system. A still greater change takes place in the nature of man as a result of his interaction with his social environment. In influencing social environment man creates a system of conventional stimuli with the idea of mastering the behavior of other people Thus he creates conditions for the mastery of his own behavior, radically altering thereby the principal mechanism of behavior itself.

These stimuli-signs, which at an early stage of development took on the form of stimuli acting from without, when turned upon themselves, are capable of being transformed in the process of psychological development into internal signs. The synopsis, which in principle exactly corresponds to the cards of our experiments, is

necessary to every lecturer at the beginning of his career, keeping his attention on the consistent unfolding of the contents of his speech. It is soon cut down in size, and the large sheaf of papers, with its methodical guiding text and mass of notes in colored inks, gradually gives place to a number of bits of paper covered with a few words, which are almost never looked at.

The external stimuli-means are at first not sufficiently specialized. In the examples given by us, objects filling the rôle of means, organizing the behavior of the Chinese postman, are as much mnemotechnical signs as signs of attention, just as in our experiments colored cards usually fulfilled both these functions. Only at a higher stage of their development, when they are divided into two lines—the line of further development of external means and the line of transformation of external means into internal means—we meet with a system of fully differentiated external signs, such as, for instance, writing and connecting signs.

A much greater obstacle is presented by the problem of the differentiation of internal stimuli-signs. When they are "growing in," external signs are not only deprived of their original form, but undoubtedly assume new and peculiar features. Their functional classification is possible only in a conditioned sense, entering the process, they determine not the direct elementary psychological functions as such, but those operations at the biological basis of which these functions lie.

In the analysis of the higher forms of behavior it is impossible, therefore, to oppose to each other or else to associate the lower psychological functions, treating them as separate items and thus mechanically reducing these higher forms of behavior to their primary, simple mechanisms.

Summary

The development of a child's attention is not confined only to the development of its primary biological forms, but includes the transformation of these elementary forms into new and higher forms. The child's attention, which at first is involuntary, i.e., depends directly on the action of stimuli, is transformed in the process of its development into the voluntary attention characteristic of an adult. This process of transformation takes place on the basis of the control of the child's attention from without, with the help of external stimuli. The child, feeling the effect of these external

stimuli on himself and learning in his turn to react on others around him, becomes capable of using external stimuli with the idea of organizing his own behavior. By thus controlling stimulation, the child controls his own attention; by submitting to the natural laws of his own behavior, he thus makes the latter submit to him, and in this sense transforms it into voluntary behavior.

Research work on the development of voluntary attention, which was carried out by means of special methods, confirms the above theory.

Children of early preschool age prove incapable of actively using external auxiliary stimuli as means of organizing their own behavior. The attention task is fulfilled by all the children in exactly the same way, both in the series of experiments without auxiliary means and in the series in which the child is called upon to use definite auxiliary means. In early school age, however, the child learns to organize his behavior from without, with the help of external stimuli, and the difference in the indices of these two series of experiments reaches its maximum. With the transition to a more advanced age, the rôle of external means organizing behavior becomes less significant. The function fulfilled by these external means gradually passes over to the internal elements of the experiment. What takes place now is emancipation from the external forms of the stimuli which were at first indispensable. The external signs of the operation are transformed into internal signs.

In this way the development of the voluntary attention of the child should pass through a stage when his behavior is controlled with the assistance of external stimuli-signs, which are subsequently replaced by internal signs.

References

1. Baldwin, J. M. Mental development in the child and the race: methods and processes. New York & London: Macmillan, 1895. Pp. xvi+496.
2. ———. Social and ethical interpretations. New York & London: Macmillan, 1897. Pp. xiv+574.
3. Darwin, C. The descent of man. London, 1872. (2nd ed., 1888.)
4. Dobrinin, N. Z. [The fluctuation of attention.] (Russian.) Moscow, 1928.
5. Leontiev, A. N. [The development of the indirect memory.] (Russian.) *Prob. Defectol.*, 1928, No. 4.
6. ———. [The dialectic method applied in the psychology of memory.] (Russian.) In [*Problems of Marxian education.*] Moscow: Acad. Comm. Educ., 1929.

7 ———— [Researches in the cultural development of the child I The problem of the dialectic method in the development of child's memory] (Russian) In [*Problems of Marxian education*] Moscow Acad Comm Educ, 1929

8 LUBBOCK, G Prehistoric times. London, 1872

9 LURIA, A. R The problem of the cultural behavior of the child. *J Genet Psychol*, 1928, 35, 493-506

10. ———— [Experimental psychology and the development of the child.] (Russian.) *Nauchnoje Slovo*, 1929

11 ———— [Ways of the development of child's thinking] (Russian) *Estestwosnanie i Marxian*, 1929

12 ———— [Researches in the cultural development of the child III Matters and facts to the genesis of child's writing] (Russian) In [*Problems of Marxian education*] Moscow Acad Comm Educ, 1929

13 LURIA, A R, & MOROZOVA, N. G [Instrumental reaction in children] (Russian) *Proc Psychol. Lab Acad Comm Educ*, Vol 6

14 REVAULT D'ALLONES, G L'attention indirecte *Rev Phil*, 1914, 77, 32-54

15 ———— L'attention. In *Traite de psychologie*, de G Dumas, 1923 Pp 846-919

16. RIBOT, J. La psychologie de l'attention. Paris, 1888.

17 SCHURTZ, — History of primitive culture

18. VYGOTSKI, L S [Pedology of the school child] (Russian.) Moscow Second Univ. Moscow, 1928

19 ———— [Genetic analysis of thought and speech] (Russian.) *Estestwosnanie i Marxism*, 1929

20 ———— The problem of the cultural development of the child *J. Genet Psychol*, 1929, 36, 414-434.

21 ———— [Researches in the cultural development of the child II The development of the active attention in the children] (Russian) In [*Problems of Marxian education*] Moscow Acad Comm Educ., 1929

22 ———— [Development of the active attention in children] (Russian) In [*Problems of Marxian education.*] Moscow Acad Comm Educ, 1929

23. VYGOTSKI, L S, & LURIA, A R [Essays on the history of the behavior] (Russian) Moscow, 1920 Pp 231

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ÉTUDES DU DÉVELOPPEMENT DE LA CULTURE CHEZ L'ENFANT. III LE DÉVELOPPEMENT DE L'ATTENTION VOLONTAIRE CHEZ L'ENFANT

(Résumé)

Le développement de l'attention d'un enfant n'est past limité seulement au développement de ses premières formes biologiques, mais inclut la transformation de ces formes élémentaires en des formes nouvelles et plus élevées. L'attention de l'enfant, laquelle est d'abord involontaire, c'est-à-dire, dépend directement de l'action de stimuli, se transforme dans le procédé de son développement en l'attention volontaire caractéristique d'un adulte. Ce procédé de transformation a lieu sur la base du contrôle de l'attention de l'enfant du dehors, à l'aide de stimuli externes. L'enfant, en se rendant compte de l'effet de ces stimuli externes sur lui-même et en apprenant à son tour à réagir sur les autres autour de lui, devient capable de se servir des stimuli externes avec l'idée d'organiser son propre comportement. En contrôlant ainsi la stimulation, l'enfant contrôle sa propre attention, en se soumettant aux lois naturelles de son propre comportement, il fait soumettre celui-ci à lui, et en ce sens le transforme en comportement volontaire.

Des recherches sur le développement de l'attention volontaire, faites au moyen de méthodes spéciales, confirme cette théorie.

Les enfants du premier âge préscolaire se montrent incapables de se servir activement des stimuli auxiliaires externes comme moyen d'organiser leur propre comportement. La tâche de l'attention est faite par tous les enfants d'exactement la même manière, et dans la série d'expériences sans moyen auxiliaire et dans la série où il faut que l'enfant se serve de moyens auxiliaires définis. Au premier âge de l'école, cependant, l'enfant apprend à organiser son comportement du dehors, à l'aide de stimuli externes, et la différence dans les indices de ces deux séries d'expériences arrive à son maximum. Avec la transition à un âge plus avancé, le rôle des moyens externes dans l'organisation du comportement devient moins signifiant. La fonction remplie par ces moyens externes passe peu à peu aux éléments internes de l'expérience. Ce qui a lieu maintenant, c'est l'émancipation des formes externes des stimuli, lesquelles ont été d'abord indispensables. Les signes externes de l'opération se transforment en signes internes.

Ainsi le développement de l'attention volontaire de l'enfant doit passer par une étape où son comportement est contrôlé à l'aide de signes externes de stimuli, lesquels sont remplacés après par des signes internes.

LEONTIEV

STUDIEN ÜBER DIE KULTURELLE ENTWICKLUNG DES KINDES · III DIE ENTWICKLUNG DER AUFMERKSAMKEIT BEIM KIND

(Referat)

Die Entwicklung der Aufmerksamkeit eines Kindes beschrankt sich nicht nur auf deren primare biologische Formen, sondern umfasst die Umbildung dieser Elemente in neue und hohere Formen Die Aufmerksamkeit des Kindes, die anfangs unabsichtlich ist, dh. direkt vom Einfluss der Reize abhangt, wird im Laufe ihrer Entwicklung in die fur die Erwachsenen charakteristische absichtliche Aufmerksamkeit umgewandelt Diese Umbildung beruht auf ausserem Zwang, der der kindlichen Aufmerksamkeit durch die Mithilfe der ausseren Reize, auferlegt wird Das Kind, das den Einfluss dieser ausseren Reize auf sich fuhlt und lernt auf andere um sich herum zu reagieren, wird befahigt aussere Reize zu gebrauchen, um sein eigenes Verhalten zu organisieren Indem es in der Weise die Reizungen beherrscht, beherrscht es auch seine eigene Aufmerksamkeit; indem es sich den Gesetzen des eigenen Verhaltens unterwirft, unterwirft es sich die letztern, und in diesem Sinne wandelt es sein Verhalten in ein absichtliches um

Forschungen uber die Entwicklung absichtlicher Aufmerksamkeit, die nach besonderen Methoden durchgefuhrt wurden, bestatigen die oben umschriebene Theorie.

Kinder im fruhen vorschulpflichtigen Alter erweisen sich als unfahig aussere Hilfsreize zur Organisierung ihres Verhaltens zu gebrauchen Die Aufmerksamkeitsaufgabe wird bei allen Kindern in genau derselben Weise erfullt, und zwar in beiden Serien der Experimente, der ohne Hilfsmittel und der, die die Kinder veranlasst, bestimmte Hilfsmittel zu gebrauchen Im fruhen Schulalter aber lernt das Kind sein Verhalten mit Hilfe ausserer Reize, von aussen her organisieren und die Differenz der Exponenten dieser zwei Experimentserien erreicht das Maximum Beim ubergang in ein hoheres Alter wird die Rolle der das Verhalten organisierenden ausseren Mittel unbedeutender Die Funktion, die durch diese ausseren Mittel erfullt wird, geht allmahlich auf den inneren Elementen des Experimentes uber Das was nun stattfindet ist die Emanzipation von der ausseren Form der Reize, die anfangs unentbehrlich war. Die ausseren Zeichen des Verfahrens wurden in innere Zeichen verwandelt

In dieser Weise sollte die Entwicklung der absichtlichen Aufmerksamkeit eines Kindes durch die Stufe gehen, worin sein Verhalten durch die Mithilfe ausserer Reizzeichen beherrscht wird, die hernach durch innere Zeichen ersetzt werden

LEONTIEV

A SCHEME FOR GRADING THE REACTIONS OF CHILDREN IN A NEW SOCIAL SITUATION*

From the Clinic of Child Development of Yale University

RUTH W. WASHBURN

The method of observing children in a social situation new to them to be described in this paper was developed because of a desire to study personality differences as revealed under these conditions It was desired to add detailed observations of the social behavior of pre-school children to observations of other fields of behavior made in the psychological examinations.

Two hypotheses underlie the study. First: *An individual may, and commonly does, behave in a given situation in a manner fundamentally characteristic of him.* For want of more accurate analysis, such individual differences in habitual ways of reacting are attributed to personality Following a number of years of study of infants and young children, the writer, in common with many other clinical and research psychologists, became convinced that important personality differences are revealed by behavior usually considered to be a side issue—accessory to the fact represented by this or that response in a test situation Undoubtedly, for many clinicians the chief interest found in the daily round of psychological examinations consists in analysis of the subtle ways in which a child has differed from his fellows in responding to one or another of the stereotyped test situations

Second: *A situation which is new to an individual evokes behavior just as truly indicative of his personality as a situation with which he is familiar* Children's attendants often state that the child has not seemed like himself while at a psychological clinic for study Can it not be argued, however, that when people and things to which the child is habituated to respond (often in a manner conditioned by those people and things) are lacking in a situation, the true nature of his personality is revealed? That one knows very clearly some of the adaptive possibilities of the individual, after having seen him in

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a situation in which he has few habits or perseverative tendencies to influence his reactions?

Many children between the ages of fifteen months and four and a half years are brought each year to the Clinic of Child Development at Yale University either for clinical study (often followed by a period of re-education), or because they are subjects in various research projects. Some of these children have been studied a number of times, thus affording a background of information against which to place observations of their social behavior. A social situation in which these children might be studied was readily available. In the "Nursery Group" the desired opportunity was found. The Nursery Group consists of six children of preschool age who are in daily attendance throughout the academic year. Children are invited to become regular members of this Group because they have been carefully studied and are known to be stable individuals, well developed physically and intellectually.

The social situation afforded by this group was new to each of the children taken into it for this study. It has common elements which make it somewhat comparable to a controlled experimental set-up, though, because it is a social situation, it cannot be controlled as a bit of apparatus can be. First, the Nursery Group remains the same throughout any academic year, though the children who make it up undergo the changes inevitable as the result of maturation and experience. Moreover, children who are members of this regular group behave from day to day in a consistent and characteristic manner. Throughout one academic year, for example, one of the children furnished spontaneously what amounted to a test situation for each of the new children introduced into the Group for study. He approached a new child and, after a few moments' observation, put his arms about him. If the new child protested, the fun was continued. If the embrace was accepted, interest ceased. Second, the room or yard and the equipment may also be considered one of the relative constants in the situation. However, one play object or another might be featured, depending upon the interests of the Nursery Group prior to the new child's entrance. It was not possible to control the hour at which the new children were taken to the nursery, because every developmental examination proceeds at a different rate of speed. Sometimes the children were indoors, sometimes in the yard. If indoors, the observer was behind the one-way-vision screen with which the Nursery is equipped. If outdoors, she was less well

concealed in a bay window overlooking the yard or behind a screen door.

Many children were watched in this social situation before the items for recording were decided upon. The common difficulties encountered in the study of social behavior of young children, adequately enumerated elsewhere in the literature (1), were vividly realized. One observer cannot both watch and write a full record. Dictation is impossible where children must be within earshot. Moreover, behavior is capable of several interpretations by as many observers. Items were necessarily chosen which could be recorded by the check method and were objectified as far as possible It became apparent, after a number of children had been watched, that there was a certain regularity about the way in which the inhibitions induced by the new situation were released. An initial period of alert but inactive observation on the part of the child was apt to be followed by a period of active exploration of the room or yard, or exploitation of some object. Vocalization was usually the last activity to emerge. This represented the skeleton or outline about which the behavior of the children differed. One child, for instance, trotted into the room, which he had not seen until that moment, saying nonchalantly, "Hello, boys and girls," and immediately engaged in active play. Others never emerged from the period of "frozen" observation. A very few took refuge in crying and were removed.

The child to be studied was taken to the Nursery by the psychologist, the mother remaining in one of the reception rooms. After the child had been put in touch with the worker in charge of the Nursery Group, and had been told the names of the children near him, the psychologist withdrew, explaining that she would return in a short time, and that the child might "stay to play." No special plan was drawn up for the adults in the Nursery They were requested to act in the way natural to them with any child in the room

Three periods of observation, each five minutes in length, were decided upon. In the initial five-minute period the examiner attempted to record, first, the number of times that the child's attention shifted if he watched adult, or child, or looked at a plaything The number of attentional shifts depended somewhat upon the amount of the activity about him, but, if the child became interested in some activity, observation of others dropped out. The number of attentional shifts recorded was therefore an indication of the child's type of adjustment In the initial period, also, the number of contacts

(other than observations) initiated by the child with other individuals was recorded, those with adults and children separately. There was a wide range of possibilities in the form taken by these social contacts, from approach to vocalization. Behavior of the child in response to advances made by other individuals was also recorded. If he were responsive either to adult or child, each response was noted. If he failed to respond to the advance of either adult or child, each failure to respond was noted. The difficulties encountered in the interpretation of such behavior can be readily understood. Suppose, for instance, that the adult made a suggestion to the child involving the use of a spoon and the child failed to react or reacted negatively. It was decided to check this as unresponsive. Since the activity desired by the adult had not been carried out, in going over the checked cards, "unresponsive" gave a truer concept of the possible range of reaction than the term negative.

In each five-minute period, the number of things actually handled by the child was recorded. Following each five-minute period (all times were kept with a stop-watch) a few moments were taken to write notes, evaluating check marks. The above episode, for instance, might be briefly described as "refuses spoon offered by adult."

In the second five-minute period the amount of time that the child was active was recorded. Two stop-watches were used. One measured the length of the period. The second watch was set in motion only when the child was active. Activity was defined to include motion of the trunk or limbs. If the child stood in one spot and simply moved his head to make his observations, it was not recorded as activity. Here, as elsewhere, the method must be much refined. Quantity of activity can be roughly estimated in this way, but not its qualitative aspects. One child might occupy almost a minute moving constantly but very slowly across the yard, while another child had covered five times the amount of space and had used all parts of the body more vigorously in the same period of time.

The third five-minute period was devoted to recording the vocalizations of the child. Words were not recorded, but each time he spoke a check mark was placed in the appropriate division of the card. Here were recorded the number of times that the child spoke either to an adult or to a child, the number of times he spoke in response to either an adult or child, the number of times he failed to respond vocally when addressed by adult or child, and the number of times that he talked to himself. Under this last subdivision factual

and expressive vocalizations were differentiated as it was found that sometimes the child talked to himself calmly about what he was doing or about the properties of the thing with which he was occupied, and that, at other times, he squealed or was otherwise expressive, even though solitary. In certain instances such expressive behavior was intended indirectly to attract the attention of others, even though not apparently addressed to them. Again many refinements in technique suggest themselves.

The card used for recording the above observations was as follows:

Periods 5'	Checks	Remarks
Social contacts Observation only of: Adult Child		
Self-initiated contacts Adult Child		
Approached—responsive To adult To child		
Approached—unresponsive: To adult To child		
Objects handled		
Gross muscular activity: (Legs, arms, trunk) Objects handled		
Vocalizations: Self-initiated. Adult Child		
Responsive: Adult Child		
No response to Adult Child		
Soliloquy—factual		
—expressive		
Objects handled		

TABLE 1

Age (months)	18 - 23	24 - 29	30 - 35	36 - 41	42 - 47	48 +	Total
Number of Children	14	12	8	14	8	11	67

On the reverse side of the card the date, the child's name, his age, and intellectual status were recorded, as well as the names of the children present on the day of the observation and the psychologist's summary of the period of observation, which included atypical features and a critical estimate of the child's type of adjustment.

Some 67 records were made during the academic year 1930-1931. The age distribution of the children studied was as shown in Table I

With respect to economic background and intelligence the group was heterogeneous The homes of the larger proportion of the children, however, were average or somewhat above the average With respect to intelligence, also, the majority of the children were average or above Only one of the children observed was defective, a very small number were a little below the average Too few children have as yet been studied to make generalizations in terms of the correlation of intelligence and social behavior (as observed in this situation) possible That the two are not inter-related is indicated by one or two of the subdivisions of the study which are to be described

In order to make it possible to compare one record with another, the responses in each division were rated as follows 1 response was rated *E*, 2, *D*, 3, *C*, 4, *B*; 5 or more, *A*. Thus, suppose a child talked once to a child and three times to an adult His respective ratings would be *E* and *C* in these two divisions With respect to muscular activity, if the child were active less than one minute out of the five, his rating was *E*, one to two minutes, *D*, two to three minutes, *C*; three to four minutes, *B*; four to five minutes, *A* These ratings are arbitrary, based only upon careful study of the records More children must be studied before statistical distribution can be made That the ratings are too rigorous is indicated by the very small percentage of *A*'s earned in any subdivision Time spent in observation by the child was considered separately and was estimated in terms of little, medium, or much In order to have the ratings for "observation" comparable with the others in terms of freedom from inhibition, it was necessary to reverse them quantitatively, since the more observation there was the less "free" the

TABLE 2

Number of subjects	14	12	8	14	8	11	67
Age level (months)	18 - 23	24 - 29	30 - 35	36 - 41	42 - 47*	48 +	
Observation, first period, all degrees	78.6%	100.0%	100.0%	100.0%	87.5%	81.8%	
Initiates contact with children	78.6%	50.0%	25.0%	57.2%	25.0%	54.5%	
Initiates contact with adults	42.8%	41.7%	62.5%	21.8%	25.0%	54.5%	
Activity	100.0%	100.0%	100.0%	93.0%	100.0%	100.0%	
Talks to children	42.8%	75.0%	25.0%	57.2%	12.5%	54.5%	
Talks to adults	35.7%	66.6%	25.0%	42.8%	12.5%	45.4%	
Uses playthings in third period	100.0%	100.0%	75.0%	78.6%	62.5%	81.7%	
Soliloquy—factual	21.4%	41.6%	37.5%	42.8%	0	27.3%	
Soliloquy—expressive	35.7%	50.0%	37.5%	42.8%	37.5%	36.3%	

*Percentages at the 42 - 47 age level are influenced by the inclusion of two markedly inhibited children in a small group

child was Much observation was therefore rated *E*, medium, *C*, little, *A*. A change from a *C* rating to an *A* rating in the observation division therefore indicates that the child was less occupied with watching others and freer to carry on his own pursuits.

That the items chosen for observation were independent of age with respect to the frequency of their manifestation is indicated by the figures given in Table 2. Percentages are here estimated for the total number of children who behaved in the indicated way at each age level, regardless of rating.

The behavior categories selected for the above summary, as well as those which follow in the paper, are those which depended chiefly upon the child's own impulse to react to his surroundings. Percentages are also similar in other categories, but are more difficult to interpret, lacking further refinement in the method, as variable stimulation by other individuals is implicated Thus a child might be rated *B* for response to adults. This rating might either indicate that he was an unusually responsive child or that the adult had made an unusual effort to help an inhibited child to adjust to the situation. Comparison of the percentages of children at each age level who earned the *C* and *D* ratings for activity also indicates independence of the age factor.

That the scheme is one which may be useful for the study of personality differences was indicated by a comparison of the records of

TABLE 3

Age level (months)	18-23	24-29	30-35	36-41	42-47	48+
Number of subjects	14	12	8	14	8	11
Activity rating *C*	35.7%	25.0%	25.0%	28.6%	25.0%	9.0%
Activity rating *D*	21.4%	41.7%	25.0%	21.4%	12.5%	63.5%

two children of very different personality make-up. These two children, *X* and *Y*, were first studied before they were a year old. They were members of a group of infants who were being studied at a Well-Baby Conference. They were of especial interest to the psychologist because of the marked difference in their social behavior. In other respects there was marked similarity both in the children and in their environment. Their mothers had been at school together, the families lived within a few blocks of each other in a neighborhood marked for its economic homogeneity. The children were the first ones in their respective families, whose standards of child care were very similar. There was but three days' difference in the chronological ages. Computed rate of mental development was the same for the two children. Following examinations just before the children were ten months of age, the psychologist made the following summary:

> "These two babies were seen on the same day in immediate succession. Inspection reveals the fact that their records on the monthly developmental schedules are practically identical. *X*, however, gives an impression of development superior to that of *Y*. The question arose as to whether this was due to *X*'s greater social security, self-confidence. *Y* has an air of suspicion, does not react at once to the material, cries if the examiner takes her. So far as one can judge of successive rather than simultaneous performances, the quality of *X*'s performance is very similar to that of *Y* with the exception of the "stepping movement" situation. *Y* refuses to come to the examiner, does not "step out" when taken by her mother. *X* comes readily and at once begins stepping movements. Later, on catching sight of the examiner, *X* held out her arms to invite the experience again. Both children probably have about an equal amount of social stimulation. Will these personality differences persist? Will *X* continue to give an impression of better development? Will this impression be only superficial?"

When X and Y were eleven months of age a comparative examination was arranged at which two other observers[1] were present. Excerpts from the summary made following this examination indicate that there was agreement as to the outstanding personality differences.

> "Even after the hour of comparative examination, it is difficult to determine with confidence which of the two children has the greater intelligence . . . The outstanding difference between these two infants consisted in the relative emotional poise on the one hand (X) and in almost unremitting querulousness on the other (Y) This querulousness was audible and occasionally rose to the pitch of brief crying with tears, but for the most part consisted in a mild complaining attitude which was too continuous and subdued to be called fretfulness."

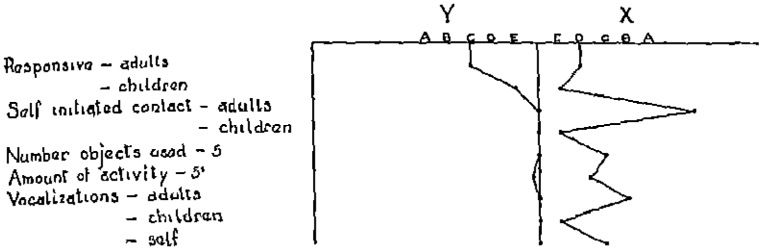
The two children were seen at infrequent intervals following these early examinations with the constant differentiation that social adjustment was made more easily by X than by Y. When they were brought to the clinic successively at five years of age, the Nursery Group was available and the behavior of each child in this new situation was observed. The accompanying charts present the situation graphically. Home standards and experience continued strikingly similar Both children had had school experience; both children came to the clinic unaccompanied by their mothers. Both children made a good adjustment to the examiner (who was remembered from the previous year) during the period of the examination Even during the examination, the personality differences were evidenced by difference in comments X frequently said of a proposed test, "Oh, that's easy," and Y as frequently remarked, "I can't do that." The actual examination records were almost identical, as may be seen by glancing at Graph I A

The profile for X, Graph I B, contrasts vividly her behavior in a new social situation with that of Y.

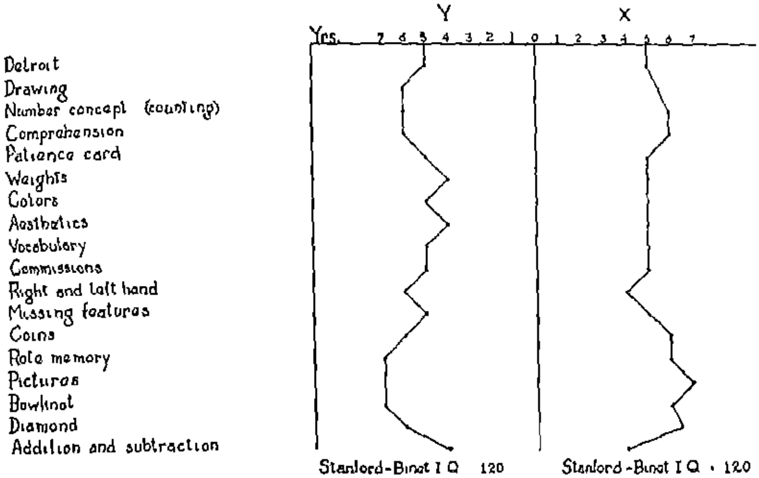
A third excerpt from a summary describes the difference in the behavior of X and Y while they were with the Nursery Group.

> "Y stood for the most part observing alertly but not entering in. X knew what she wanted to do and asked permission to do it Most of her social reference was to adults, but she

[1]Dr A L Gesell and Dr E E. Lord.



A Comparison of Developmental Examinations



B. Comparison of Behavior in a Social Situation New to X and Y

CHART 1

was at moments in social contact with the other children and was talked to by other children One of the regular members of the Group made his habitual approach ("Can you talk? Talk, then!") to *X* but not to *Y* *X* was loath to leave, wished to continue enjoyed activities *Y* was glad to leave That *Y* was not inhibited by a new dress, as was thought at first, but by the social situation was evidenced by the fact that in spite of the new dress she displayed climbing and tumbling activities, similar to those she had witnessed in the other children, as soon as she reached home and regained a feeling of security and freedom from inhibition"

The easy adjustment made by X as an infant to new situations and new people remained characteristic of her, then, each time that she was seen up to five years of age Y, on the other hand, with similar endowment and environmental influences, was consistently insecure, distrustful not only of others but of her own capacity, when confronted with new situations and new people.

Such personality differences might be described by a number of terms—a child might be called extraverted or introverted; socially aggressive or socially withdrawn The fact of interest here is that the differences were readily recordable in a short period of time by the use of the scheme under discussion and are capable of graphic representation.

A group of children of nursery-school age was also studied in the way described above. Records were made at one of the private nursery schools of eleven children on the day that they first entered.[2] In order that the record might be made within a few minutes of their arrival on the first day of their attendance at school, the day and hour of arrival were carefully arranged with the mothers. Since the children had not been to the school before except for a psychological examination, did not know either the teachers or the children, they were thus placed in a new situation very comparable to that offered by the Nursery Group at The Clinic of Child Development. After the winter's experience at the nursery school, these eleven children were taken individually to The Clinic of Child Development, where records were made of their behavior when they were introduced into the Nursery Group. One thus had two records of behavior in comparable new situations. For each child approximately eight months maturation and social experience of the type offered by a nursery school had intervened. Since much of the equipment was similar in the two places, the room or yard and the adults and children presented the unfamiliar features on the occasion of the second record. If one tries to treat the records as a group, they at once become meaningless. It is only when the records are considered individually that they have meaning. This must of necessity be so, since the tendencies emphasized by an uninhibited child are cancelled by the record made by an inhibited child.

In Table 4 the ratings of the eleven children are summarized. The ratings for each child's two records are adjacent.

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[2]Thanks are due Miss Dorothy A Cannon for her interest and cooperation

TABLE 4

No of subject	1	2	7	8	4	3	5	6	9	10	11
Record	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2
Observation	E A	E E	C C	E E	A E	E E	A C	C C	E E	E E	E E
Initiated contact with children	C A	O O	O E	O O	C C	E O	O A	O O	O O	D O	D C
Initiated contact with adult	O O	O O	O O	O O	B E	O O	A E	E C	O B	O O	O O
Activity	C B	E D	E C	E E	D D	D E	B B	B B	D D	D C	D B
Talked to children	O C	O O	O O	O O	A A	O O	A D	D O	O O	O O	E O
Talked to adults	O O	O O	O O	O O	A C	O O	O O	C O	E C	D O	E E
Used playthings third period	D C	O O	O A	O D	A B	E O	B B	D D	A C	D A	B B
Soliloquy—factual	O O	O O	O O	O O	A E	O O	E A	O O	E O	O O	O O
Soliloquy—expressive	O E	O O	O O	O O	A B	O O	O C	O E	O O	O E	A C
Percentage of identical ratings	33.3	89.0	66.6	89	33.3	66.6	33.3	55.6	55.6	44.4	55.6
Percentage of higher ratings 2nd record	66.6	11	33.3	11	0	0	33.3	22.2	22.6	33.3	22.6
Percentage of lower ratings 2nd record	0	0	0	0	66.6	33.3	33.3	22.2	22.6	22.3	22.6
Age of children (months)	38 45	38 46	25 32	22 29	30 37	34 42	26 34	25 34	22 30	17 25	15 21

As might have been expected, three tendencies declared themselves when the records of these children were studied. Four children were less inhibited by the second new situation. Two children were more inhibited in the second situation than they had been in the first The records of the remaining five children were very similar for the two situations.

Illustrating the first tendency, children Nos. 1, 2, 7, and 8 earned ratings which moved in the direction of increased freedom. These four children were all said to have improved in their ability to adjust in a social group in the course of the winter's experience at the nursery school. The increased freedom in the case of child No. 2 will be noted to be almost negligible With respect to personality she was one of the most interesting children studied. She had been studied ever since four months of age and had consistently shown a marked degree of social insecurity She watched the other children in the nursery school for weeks before she became free enough to use the materials herself It was also a matter of weeks before she spoke to anyone, adult or child, at the school. Before leaving school she had begun to use blocks, making very interesting constructions, to approach another child occasionally and to respond to the adults in whispers, and occasionally aloud This change in the direction of greater activity in a social group is reflected in a slightly higher rating for activity when seen in the second new social situation. Her behavior in the two situations was, however, strikingly similar

Child No 8 also behaved very consistently in the two situations with slightly greater freedom in the use of toys on the second occasion She had been thought of at the nursery school as aloof and comparatively independent of people

Child No. 7 had had a very difficult time in making her initial adjustment at the nursery school. She was markedly dependent on adults It was some time before she was able to establish relations with the children. Other children of similar chronological age did so more easily. Although she did not cry on the second occasion as she had on the first and showed definite improvement in her ability to make one of a group, she earned no high ratings in the situations which required social initiative. She was freer in the sense that she moved about the room and explored many of the objects, but she made only one advance to any other individual. Maturation and experience had certainly had their effect She was busy throughout the second period as she had not been in the first. A stranger might

not have recognized her as a new child. She was solitary in the second new social situation, though on easy terms with many of the children in the social situation to which she had become habituated

Child No. 1 was one of those who "flowered" while in the nursery school As he was an only child and had had only few contacts with others before entering the school, it may be presumed that his ability to make contacts with others was latent and needed only the proper environment to develop.

Of the two children who were less free on the second occasion than they had been on the first, child No 4 was a particularly out-going child when first seen He was in the early months of the year with the younger group of children in the nursery school He appeared to be better developed than the others and he was therefore placed in the older group. The wisdom of this step was questioned by the teachers, as he became a follower where he had been a leader It will be noted that he earned ratings in every category but one, that the difference in the two adjustments may be considered to be quantitative rather than qualitative. That is, he was still free in a new group, but less impulsively out-going than he had been when first seen. The second child in this group (No. 3) was a very different type of child, consistently withdrawn socially and a matter of concern to the teachers because she did not become freer. Even though both illustrated the same tendency, the difference between the two children is vividly brought out by a comparison of the four sets of ratings.

The group illustrating the third tendency consisted of children Nos 5, 6, 9, 10, and 11. They were relatively free children when first observed and in each case the two records do not differ markedly In each case higher ratings on the second record in one or two categories are offset by lower ratings in one or two others In descending order with respect to degree of social initiative they are Nos. 5, 6, 11, 9, and 10

In Graph 2 the records of three children representative of three types of adjustment are shown.

Record 1 is that of a child who was very much inhibited by the new situation. She spent the whole period standing with her finger at her mouth watching the children. Activity consisted in shifting from one foot to the other. She was unresponsive to two children who approached her Record 3 is that of a child who was not inhibited by the new situation. From the moment of his entrance he

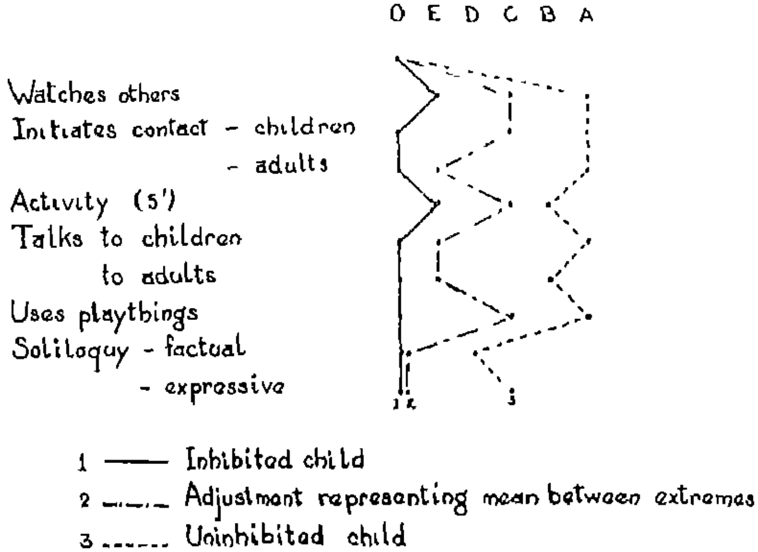

CHART 2

acted, in popular terminology, as if "entirely at home." Record 2 represents the mean between the two extremes. The child was neither particularly impulsive nor much inhibited. He looked the situation over and proceeded to busy himself with a fair sense of security and willingness to approach others.

Conclusions

1. Though the described scheme for observing the behavior of children in social situations new to them must be much further refined, in its present state of development it is useful in the detection and graphic representation of personality differences in children of preschool age.

2. Behavior as observed and recorded in the new situation was characteristic of the children as they were known in other situations. This is important if the method is to be used when a child is studied for the first time under conditions similar to those of this study, as it indicates that one can take the results to be reliable indicators of the child's personality traits.

3. It was true of the children observed that the degree of free-

dom from inhibition in a new social situation was not determined by age or relative mental development.

4. The passage of time, with all that it implies in terms of maturation and experience, modified but did not alter the type of the reaction of the children studied.

Reference

1 THOMAS, D S, *et al* Some techniques for studying behavior New York Bur. Publ, Teach Coll, Columbia Univ.

Yale University
New Haven, Connecticut

MÉTHODE D'ÉVALUER LES RÉACTIONS DES ENFANTS DANS UNE SITUATION SOCIALE NOUVELLE

(Résumé)

On a fait une méthode d'évaluer les réactions des enfants d'âge préscolaire dane une situation sociale nouvelle pour eux On a divisé les observations en trois périodes, durant chacune exactement cinq minutes Dans la première période on a noté les changements de l'attention de l'enfant pendant qu'il *regarde les autres et ses contacts initiés par lui-même avec un adulte ou un* enfant; dans la deuxième période on a noté la durée du temps où il est actif; dans la troisième période on a noté ses vocalisations, initiées par lui-même ou en réponse à d'autres, ou son soliloque. Au moyen de cette méthode il a été possible de représenter graphiquement ses différents types de réaction Le comportement observé et noté dans la situation nouvelle a été caractéristique des enfants, comme on les a connus en d'autres situations Les réactions des enfants observées dans deux situations sociales nouvelles, avec un intervalle de huit mois entre les observations, ont été modifiées mais non changées en type.

WASHBURN

EIN SCHEMA ZUR MESSUNG VON KINDLICHEN REAKTIONEN IN NEUEN GESELLSCHAFTLICHEN SITUATIONEN

(Referat)

Es wurde ein Schema festgelegt zur Messung von Reaktionen vorschulpflichtiger Kinder in gesellschaftlichen Situationen, die für sie neu sind. Die Beobachtungen wurden in drei je funf Minuten lange Zeitabschnitte zerlegt Im ersten Abschnitt wandert die Aufmerksamkeit des Kindes, wenn es andere beobachtet, es wurden seine selbstveranlassten Kontakte mit Erwachsenen oder Kindern aufgezeichnet Im zweiten Abschnitt wurde die *Dauer der Aktivitat registriert Im dritten wurden seine selbstveranlassten* und seine reaktionsweisen Vokalisationen aufgezeichnet, und zwar Selbstgesprache sowohl wie Gesprache mit andern Indem man dieses Schema anwandte, war es moglich, verschiedene Reaktionstypen graphisch darzustellen Das in neuen Situationen beobachtete und aufgezeichnete Verhalten der Kinder erwies sich als charakteristisch, wenn verglichen mit dem in andern Lagen bekannten Die in neuen Situationen beobachteten Reaktionen, vor und nach einem achtmonatlichen Unterbruch, unterscheiden sich zwar, sind aber dem Typus nach gleich.

WASHBURN

A STUDY OF THE EMOTIONS OF CHILDREN WITH PARTICULAR REFERENCE TO CIRCULATORY AND RESPIRATORY CHANGES*[1]

From the Psychological Laboratories of the University of Wisconsin

WILBERT S. RAY

Physiological methods of investigating emotions have been used in several studies, but always with adults This paper is a report of an attempt to apply the same methods to children. Children's reactions are theoretically more naive and less overlaid with learning than are those of adults, and it would seem that conditions which are common to all individuals should show up more clearly with children than with adults. On the other hand, children certainly offer difficulties not found in using adults as subjects Children are more shy, in general, than adults. They do not follow directions as well; several of our records have been vitiated by the fact that the children did not sit quietly enough to give a record which could be interpreted Children do not give verbal reports which are at all reliable. This statement is illustrated by the present case The stimulus used was designed to arouse an emotion of fear. After the experimental session was finished the child was asked if he had been frightened, and he almost invariably denied that he had been From the experimenter's own experience with the apparatus and from observation of the children's behavior, it seems necessary to conclude that this reply was due to a social training which places more emphasis on bravery than on truthfulness

SUBJECTS

The subjects used were 25 boys from Grades 3 to 7, inclusive, of the Draper School, Madison, Wisconsin.[2] They ranged in age from

*Recommended for publication by V A. C. Henmon, accepted by Carl Murchison of the Editorial Board, and received in the Editorial Office, October 2, 1930

[1]This work was done at the University of Wisconsin under the direction of Professor V. A. C. Henmon I am grateful for his supervision and his helpful suggestions.

[2]My thanks are due the Madison Board of Education and to Miss A R Marvin, Principal of the Draper School, for permission to use these

7 to 12 years, and in IQ from 73 to 144. They were selected at random by their teachers and by the school principal.

APPARATUS

The stimulus used was one of the two "primary fear stimuli," a sudden loss of support. This was provided by a chair which dropped for a distance of two to three inches, the actual distance depending on the weight of the subject. This chair was fitted up in the University of Wisconsin Machine Shop. A cylinder was fastened to the bottom of a small Morris chair. This moved up and down, carrying the chair with it, on a piston extending up from the floor. Two triggers were provided, one to hold the chair up and one to catch it when it fell and prevent a rebound. In order to prevent a jar at the end of the fall, the legs of the chair were removed and pistons fastened in their places. Each of these pistons moved in a cylinder bolted to the floor. The cylinder contained a coil spring built to be completely collapsed by a weight of 40 pounds. Thus, a total weight of 160 pounds, including the weight of the chair, was necessary to completely collapse the springs and give a jar at the end of the fall. All pistons and cylinders were greased to eliminate noise as far as possible. The pistons and springs were so arranged that the chair fell about an inch before touching the springs. A foot lever jerked out the trigger holding up the chair and allowed it to fall by its own weight plus the weight of the subject. As the lever extended under a table placed just to the left of the subject's chair, the experimenter could sit at this table and press the lever with his foot without the subject's knowing that anything was about to happen.

A detailed picture of the bottom of the chair is shown in Figure 1. The two triggers are shown, one attached to the foot lever. The wire attached to the other trigger and running to the chair leg farthest in the foreground was used in pulling out this trigger when the chair was raised. The wooden piece in back of the chair carries electrical contacts which actuate an electromagnetic marker when the chair falls.

The subjects' reactions to the stimulus were recorded by a Sumner pneumograph and a modified form of the Erlanger sphygmomanometer. These instruments were connected with Marey tambours for

children, and to Miss Marvin and the various teachers concerned for their help in securing the cooperation of the subjects.

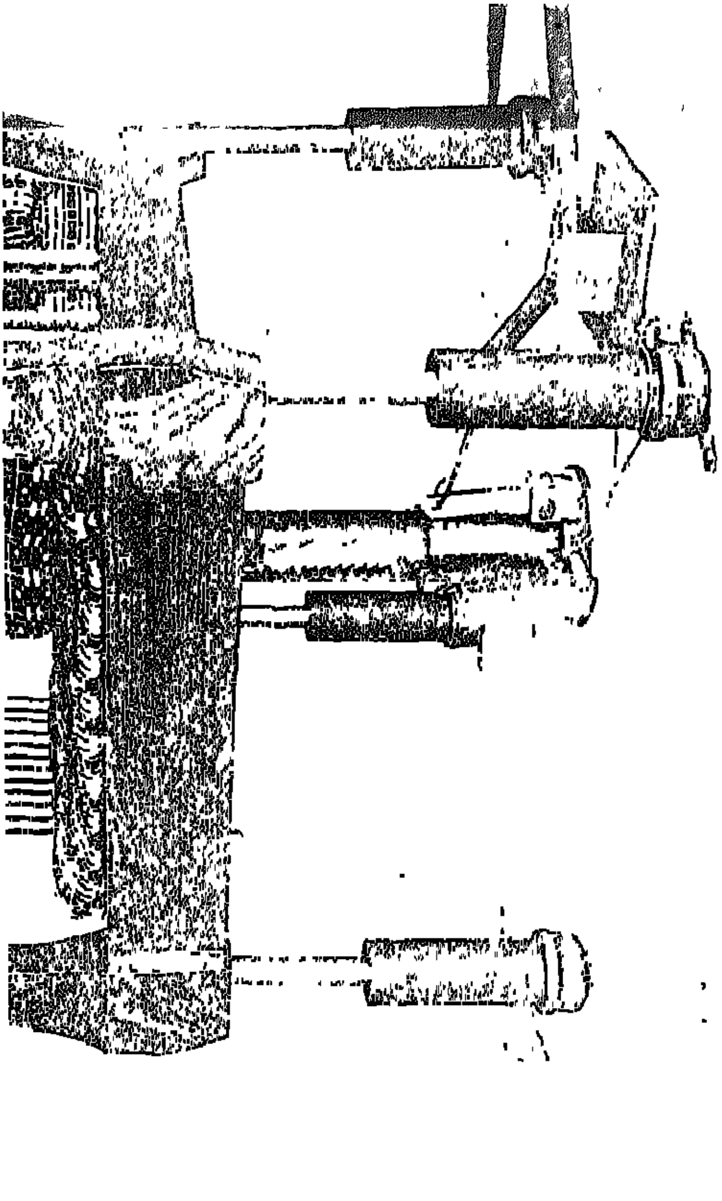

FIGURE 1

recording the reactions on smoked paper. A time record was made with a Jaquet chronometer. The markers were arranged in a comparatively straight line to mark on a 10-inch smoked paper carried on a double-drum kymograph Scratch marks were made at the beginning of the record for use in measuring the record.

Procedure

The experimenter called for the child at the school and walked up across the campus to the laboratory with him. Wraps were removed in the experimenter's office, and, on entering the experimental room, the child was invited to sit down There were only two chairs in the room, one for the experimenter and one for the subject As the experimenter's chair was pushed under the table, the natural place for the child to sit was in the experimental chair. Thus no particular attention was drawn to the chair itself The child was now given the Stanford-Binet Intelligence Test. This not only served to determine the child's mental age, but also gave him time to become somewhat accustomed to his new surroundings.

Immediately after the conclusion of the intelligence test, the apparatus was adjusted in a manner as matter-of-fact as possible, an attempt being made to distract the child's attention from the uncomfortable apparatus by talking to him The child was now assured that nothing would hurt him and that if either part of the apparatus did hurt it would be loosened immediately. The subject was asked to sit as still as possible, this being emphasized as if it were the important part of the whole proceeding.

Two or three preliminary runs were made with the recording apparatus in place, but with no stimulus, the sphygmomanometer cuff pressure being released at the end of each Each of these runs lasted from one to two minutes and was succeeded by a rest of two to six minutes. Thus it was hoped to allay any apprehension felt toward the apparatus and to remove, at least partially, those effects always present due to the apparatus itself No measurements have been made of these preliminary records

After an interval of five minutes or more, the test run followed. A "normal" record was taken for one minute and then the chair stimulus was applied The record continued after the stimulus for at least half a minute, and usually for over two minutes.

Measurements of Records

The jerk of the falling chair played havoc with the markers: so a period of five seconds just after the stimulus has been discarded in each record This period has been taken as long enough to obviate the mechanical effects of the falling chair in all cases. Inspection of the records seemed to show that most of the macroscopic changes had disappeared in 20 seconds. After discarding 5 seconds, this leaves a 15-second period for measurement In addition to this period, three other periods similar in length have been measured, one just before the stimulus, referred to hereafter as the "A" period; one starting three-quarters of a minute before the stimulus and ending half a minute before the stimulus, referred to hereafter as the "P" period; and one the last quarter of the second minute after the stimulus, the "R" period. The period just after the stimulus is called the "B" period.

In each of these periods the circulatory rate, respiratory rate, and inspiration-expiration times were measured These are considered to be more accurate indicators than those about to be mentioned, as explained below. The amplitudes of the circulatory and respiratory tracings were measured in the A and B periods only Respiration measurements were made for five complete cycles, this running approximately 15 seconds, and all other measurements were made for exact 15-second periods.

Results

Photographs of two records are shown in Figures 2 and 3. The fourth line from the top in Figure 2 is a psychogalvanic record. These records were taken during the first part of the experiment, but were then discarded The down stroke of the marker on the respiration record represents inspiration.

The results of the measurements of the records are shown in Tables 1 and 2. Table 1 gives the raw measurements for the 15-second periods. Since one subject cannot be compared with another, each subject has been compared with himself as a control by dividing his record for one period by his record for another period. For example, the pulse-rate in Period B is divided by the pulse-rate in Period A. This gives the values found in the column of Table 2 headed *B/A* All the columns in Table 2 have been calculated in a similar manner.

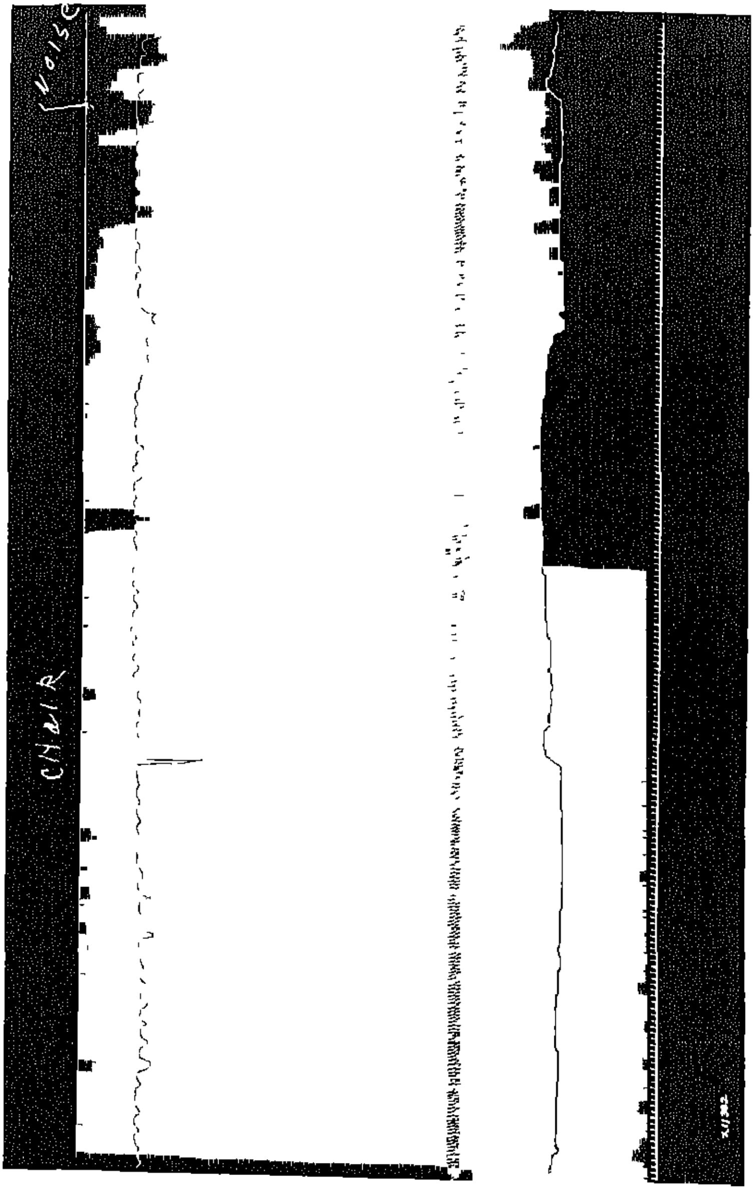

FIGURE 2

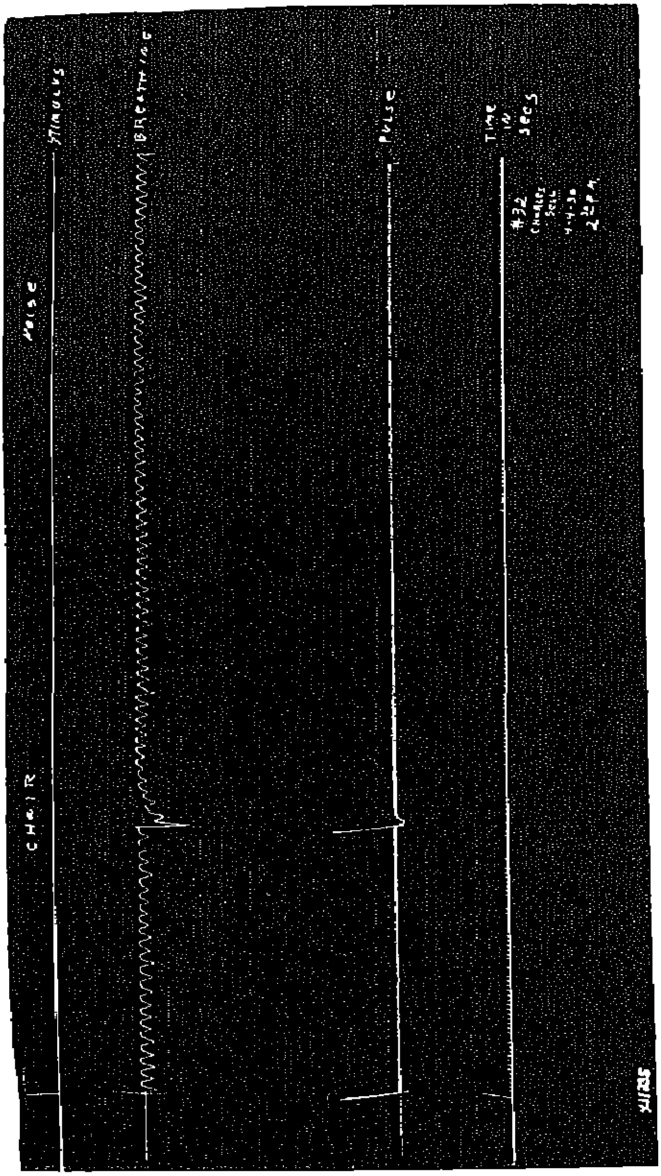

FIGURE 3

TABLE 1

Subject	Pulse-rate P	A	B	R	Respiratory-rate P	A	B	R
1	31	31	30	30	5	6	7 5	5 3
2	19 5	19	20	19	5 3	5.5	5 5	5 3
3	21 5	23	22	23	6	6	6	6
4	27	28	28	27	5 5	5 5	6	6 5
5	22	22	24	22	6 5	7	7 5	6
6	27	26	24	26	5	4 5	6 5	4 5
7	23	24	26	22	4	4 5	7 5	3.5
8	18	19	18	18	5 6	5	7	4 3
9	22	24 5	19	22	6 5	5 25	6 5	5
10	25 5	25	22		5	5	5.5	
11	23	22	23 5	24	4.7	4	4 5	5
12	21 5	21	25		5 5	6	6 25	
13	22	23	21	23	5 5	5 5	5.5	6
14	24	27	27		5.5	5	6 5	
15	19	17	17	17 5	7	6 75	8 5	6
16	25 5	25	24	.	5 5	6 5	6 5	
17		21	20			5	5	
18	20	18	18	19	7	6	6	6
19	24	23 5	21	21 5	4	4 5	5 5	4 5
20	27	26	23	22	4 5	4 5	5	5
21	22	22	18	24	5 5	5 75	5	5 8
22	22	22	24	22	6 5	6	9	6 5
23	19	19	18	19	6	5 25	6	5 5
24	20.5	21 5	23	22	5 3	5	6	5.5
25	21	22 5	23	23 5	5	5	6	6

Subject	Mean inspiration-expiration ratio P	A	B	R	Mean deviation, I-E ratio P	A	B	R
1	668	448	1 083	566	.096	016	150	046
2	503	624	667	567	054	042	054	108
3	486	761	534	325	068	111	202	061
4	373	270	401	453	128	026	022	100
5	551	580	807	557	046	063	097	088
6	.760	634	950	535	169	125	520	184
7	384	495	518	260	.065	157	134	109
8	484	533	819	511	053	120	645	141
9	523	441	497	377	076	071	050	135
10	489	455	772		056	098	237	
11	448	319	465	403	114	038	030	.089
12	414	615	620		045	148	080	
13	474	473	471	303	041	030	072	030
14	404	357	1 219		057	050	483	
15	351	605	512	476	.073	068	195	086
16	576	.541	905		091	088	353	
17		450	451			143	142	
18	748	652	495	.623	063	039	169	182
19	480	345	577	.420	.236	043	108	106
20	373	351	.348	343	.073	.017	046	043
21	568	592	.600	808	129	.119	051	.230
22	451	594	682	615	074	097	140	140
23	667	654	577	536	100	062	057	.080
24	574	582	515	580	061	.072	043	.028
25	555	617	663	635	078	098	146	063

TABLE 1 (*continued*)

Subject	Pulse				Respiration			
	Mean amplitude		Mean deviation of amplitude		Mean amplitude		Mean deviation of amplitude	
	A	B	A	B	A	B	A	B
1	127	132	005	010	289	.356	035	035
2	095	.129	006	011	078	.099	006	021
3	.081	112	003	006	230	171	060	065
4	079	109	005	012	207	231	024	053
5	052	053	006	007	.112	221	034	109
6	054	070	006	003	133	414	025	231
7	057	061	007	008	050	060	032	.012
8	109	171	007	021	158	201	009	055
9	.076	111	005	008	031	.077	008	.043
10	130	174	006	022	040	080	012	.020
11	.059	.085	008	010	130	114	010	005
12	.098	091	013	010	060	084	012	003
13	080	.094	004	007	053	.094	003	010
14	.109	107	007	015	122	180	.030	014
15	061	064	011	.006	027	020	007	.008
16	102	129	004	010	064	.073	011	010
17	126	129	.008	011	132	133	.070	026
18	.077	102	005	.016	.042	091	008	019
19	103	170	009	014	085	195	016	064
20	095	084	.007	005	072	068	019	016
21	031	060	002	.008	137	175	.020	036
22	042	054	003	004	.042	045	012	.006
23	024	034	004	003	202	193	.023	022
24	043	057	004	.005	164	121	016	015
25	030	037	0002	0045	135	172	006	014

TABLE 2

Subject	Pulse-rate ratios			Respiratory-rate ratios			Mean I/E ratios		
	A/P	B/A	R/A	A/P	B/A	R/A	A/P	B/A	R/A
1	1 00	0 97	0 97	1 20	1,25	0,88	0 67	2 42	1,26
2	0 97	1 05	1 00	1 04	1 00	0 96	1 24	1 07	0 91
3	1 07	0 96	1 00	1 00	1,00	1 00	1 57	0 70	0 43
4	1 04	1,00	0 96	1 00	1 09	1.18	0 72	1 49	1 68
5	1 00	1 09	1 00	1 08	1 07	0 86	1 05	1 39	0 96
6	0 96	0 92	1 00	0 90	1,44	1 00	0 83	1 50	0 84
7	1,04	1 08	0 92	1 13	1 67	0 78	1,29	1 05	0 53
8	1 06	0 95	0,95	0,89	1 40	0 86	1 10	1 54	0 96
9	1 11	0 78	0 90	0 81	1 24	0 95	0 84	1 13	0 85
10	0 98	0 88		1,00	1 10		0 93	1 70	
11	0 96	1 07	1 09	0 85	1,13	1 25	0 71	1 46	1 26
12	0,98	1 19	.	1 09	1 04	.	1 49	1 01	.
13	1 05	0 91	1,00	1 00	1,00	1 09	1 00	1 00	0 64
14	1,13	1 00		0,91	1 30		0 88	3 41	
15	0 89	1 00	1 03	0 96	1,26	089	1 72	0 85	0,79
16	0 98	0 96	.	1 18	1,00		0 94	1 67	
17	. .	0,95		.	1 00			1 00	
18	0 90	1 00	1 06	0 86	1 00	1 00	0 87	0 76	0.96
19	0.98	0 89	0 91	1 13	1 22	1 00	0 72	1 67	1,22
20	0 96	0,88	0 85	1,00	1 11	1 11	0.94	0 99	0 98
21	1 00	0 82	1 09	1 05	0 87	1 01	1,04	1,01	1 36
22	1,00	1 09	1 00	0 92	1 50	1 08	1 32	1,15	1 04
23	1,00	0 95	1 00	0 88	1 14	1.05	0 98	0.88	0 82
24	1 05	1 07	1 02	0 94	1 20	1 10	1 01	0 88	1 00
25	1.07	1,02	1 04	1 00	1 20	1,20	1.11	1 07	1 03

TABLE 2 (*continued*)

	Mean deviation of I/E ratios			Pulse		Respiration	
Subject	A/P	B/A	R/A	Mean amplitude ratio B/A	Mean dev. amplitude ratio B/A	Mean amplitude ratio B/A	Mean dev. amplitude ratio B/A
1	0 17	9.38	2 87	1.04	2 00	1 23	1 00
2	0.78	1 29	2.57	1 36	1 83	1.27	3 50
3	1 63	1.82	0 55	1 38	2 00	0.74	1 08
4	0.20	0 85	3 85	1 38	2 40	1 12	2 21
5	1.37	1 54	1 40	1 02	1.17	1 97	3 21
6	0.74	4 16	1 47	1 30	0.50	3 11	9 36
7	2 42	0 85	0 69	1 07	1 14	1 20	0 38
8	2.26	5 38	1 18	1 57	3 00	1 27	6 11
9	0.93	0 70	1.90	1.46	1 60	2 48	5 48
10	1.75	2 42	.	1 34	3.67	2.00	1 67
11	0.33	0 79	2 34	1 44	1 25	0 88	0 50
12	3 29	0 54		0 93	0 77	1 40	0 25
13	0 73	2 40	1 00	1 18	1 75	1 77	3 33
14	0 88	9 66		0 98	2.14	1 48	0 47
15	0 93	2.87	1 26	1 05	0.56	0 74	1.14
16	0 97	4.01		1 26	2.50	1 14	0.91
17		0.99		1 02	1.38	1 01	0 37
18	0 62	4 33	4 67	1 32	3 20	2 17	2 38
19	0 18	2 51	2.47	1 65	1 56	2.29	4 00
20	0 23	2 71	2 53	0 88	0 71	0 94	0 84
21	0 92	0 43	1 93	1 94	4 00	1 28	1 80
22	1 31	1 44	1 44	1 29	1 33	1 07	0 50
23	0 62	0 92	1 29	1 42	0 75	0 96	0 96
24	1 18	0 60	0 39	1.33	1 25	0 76	0 94
25	1 26	1 49	0 64	1 23	22 50	1 27	2 33

Discussion

The Sumner pneumograph has certain serious disadvantages In order to be effective, it must be tight around the subject's chest This causes considerable discomfort and so introduces into a situation a very undesirable feature The pain is heightened by the fact that the tube is only about an inch in width. The narrow width further necessitates that the pneumograph, to secure the best possible record, be placed at the point of greatest expansion of the subject's chest Now this point of greatest expansion changes (*a*) as the discomfort of the cincture induces a change from thoracic to abdominal breathing, or vice versa, and (*b*) with an emotional stimulus Both of these objections are overcome, at least partially, by using for a pneumograph a football bladder placed with its long axis parallel to the spine. The bladder is slightly inflated and bound to the subject's body with a strip of cloth The slight degree of inflation causes no

pain to the subject, but is still great enough to move the accompanying tambour a distance sufficient to give a good record The bladder is long enough to cover any possible movement of the point of greatest expansion except in very tall subjects

The Sumner pneumograph, moreover, gives a measurement of rate of respiration rather than of actual volume of air, which is, of course, the measurement at which we aim when we record the rate. The amplitude of the tracing from a pneumograph cannot be calibrated to give a good index of the volume of air respired. The relation varies with the vital capacity of the subject, with the shape of his chest, with the amplitude of the inspiration, and with the type of breathing, thoracic or abdominal. The body plethysmograph would overcome all of the objections mentioned, but, as it involves immersing the subject in a tank of water up to the neck, it is hardly a practical instrument for use in a psychological laboratory.

The Erlanger sphygmomanometer also has certain disadvantages It, like the Sumner pneumograph, is painful to the subject Further, it gives us a continuous measure of rates, but not of pressures. If the sphygmomanometer is set between systolic and diastolic pressures we can say that probably an increase in the size of the movement of the tambour lever indicates a rise in blood-pressure But this is not so if the preliminary pressure was set too close to diastolic, or if the pressure change is great enough Kolls (3) describes an instrument for measuring blood pressure continuously, but it uses two arm cuffs and gives a measurement of systolic rather than of diastolic pressure Physiologists are coming to believe that diastolic pressure is more important than systolic (McLeod, 5, pp 343 ff). Landis (4) describes a method for taking blood-pressures at short intervals, but not continuously. Fantus (2) also describes an instrument for taking serial records Perhaps it might be well for some experimenter to try measuring the rate of the heart with one sphygmomanometer and taking a rapid serial record with another

Many experimenters have concealed their apparatus from the subject's view by placing it in another room It is questionable whether this is wise, particularly with young subjects. Naive subjects come into the room expecting the worst, and mysterious wires and tubes running out through holes in the wall do nothing to allay their apprehension.

TABLE 3*

Column	Difference (Mean B/A—Mean A/P)	$P.E._{diff}$	$\frac{D}{P.E._{diff}}$	Chances in 100 of difference being real
Pulse-rate	0304	010	3.04	98 0
Respiratory-rate	1046	.022	4.80	100 0
Mean I/E	2170	076	2 90	97.5
Mean Dev I/E	1 2704	332	3 80	99.5

*Probable errors in this table have been calculated by the formula $P.E._{diff} = \sqrt{P.E.^2_{M_A} + P.E.^2_{M_B} - 2r_{AB} P.E._{M_A} P.E._{M_B}}$ Case No 17, having no score for the P-period, has been omitted

Discussion of Results

One subject's reactions are not directly comparable with those of another subject for various reasons. For this reason, we have attempted to compare each subject with himself as a norm by the use of the ratios described above In discussing the changes in these ratios we shall consider three questions:

1 Did the stimulus cause a real change in the activities measured? To answer this question we have searched for a reliable difference between the change from Period P to Period A (both normal periods) and the change from Period A to Period B (a normal period and the post-stimulus period). The change from P to A represents normal variation. Any difference between this change and that from A to B should be due to the variable introduced, the loss of support. The differences between the A/P ratios and unity have been calculated, as have the differences between the B/A ratios and unity (unity indicating no change), the means of these variations from unity, the differences between these means, and the *P.E.* of the differences between the means. The results of these calculations are given in Table 3

One of these differences seems to be real and the others are so close to being real that, taking them as a group, it seems permissible to conclude that the stimulus did cause a real change in the activities in question.

2 Is there a relation between a subject's change in one respect with his other changes? In an attempt to answer this question, we have correlated the deviations from unity of the ratios given in Table 2, e g., deviation from unity of the pulse-rate ratios with the

deviations of the respiratory-rate ratios, etc Only one reliable correlation coefficient has been found, that between the change in the mean I/E ratio with the change in the mean deviation from the mean of the same, $+.853 \pm .037$ That is, as the I/E ratio increases or decreases from Period A to Period B, its irregularity tends to increase or decrease. This does not imply that as the one increases the other increases. Nor does it imply the contrary, that it is not true that as one increases the other increases. Since only one of the eleven coefficients calculated was reliable, we conclude that practically nothing has been demonstrated here. These coefficients of correlations are given in Table 4

3. Do the effects of the stimulus die out quickly? To answer this question we have measured the records in the last quarter of the second minute following the stimulus, the R-period mentioned above. It has been necessary to establish an arbitrary criterion by which to judge whether or not the effect was still present in this period, as follows: the change from the A/P ratio to the B/A ratio was noted, and the change from B/A to R/A. The effect was considered to be still present if the difference between A/P and B/A was still present in the R/A ratio, or if the difference had increased. If the difference had been wiped out or reversed, the effect was considered to have disappeared. The case was marked doubtful if the difference were only partly wiped out, or if there had been no change from A/P to B/A For instance, in Table 2, under pulse-rate, the record for Subject 9 would be doubtful, Subject 5 would be marked "effect gone" and Subject 11 would be marked "effect still present" The number of cases in which the effect has been counted as gone, present, and doubtful, respectively, were, pulse-rate, 7, 6, 7, respiratory rate, 8, 6, 6; mean I/E, 8, 8, 4; and for mean deviation of the I/E, 9, 10, 1. The effect seems to disappear in two minutes in about half of the cases

Comparison with Work of Blatz

Blatz (1) performed an experiment, part of which is very similar to this Using 18 subjects, he permitted them unexpectedly to fall backwards in a chair. The points at which his records resemble ours are pulse-rate, respiratory-rate, and inspiration-expiration ratio (which he calls respiratory index) records of his first fall. He treats of the answers to two questions which are pertinent here "What is

TABLE 4

CORRELATIONS (COLUMNS HEADED B/A, TABLE 2)

Subscript	Column
1	Mean inspiration-expiration ratios
2	Mean deviation of inspiration-expiration ratios
3	Pulse rate ratios
4	Respiratory rate ratios
5	Pulse amplitude ratios
6	Mean deviation of pulse-amplitude ratios
7	Respiration amplitude ratios
8	Mean deviation of respiration-amplitude ratios

	r	$P.E._r$
r_{12}	833	037
r_{13}	—354	118
r_{14}	.161	131
r_{23}	—371	.116
r_{24}	.190	.130
r_{34}	020	135
r_{15}	—193	130
r_{18}	290	124
r_{37}	302	123
r_{36}	060	135
r_{35}	320	121

the effect of an unexpected fall?" "Did the fall induce a genuine experience of fear?"

In answer to this second question, Blatz uses the subject's report as a criterion. Since we are unable to rely on the subject's report, we have resorted to the technique described above. There seems to be indicated a change of the sort usually described as emotional This is, of course, not necessarily the same as an "experience" of fear. Here the two experiments seem to agree

With respect to the first of the above questions, the following comparisons can be made:

Pulse-rate Blatz finds that the stimulus causes an acceleration followed by a retardation No figures are given, but reference to his graph shows that the rate for the period corresponding to our B-period is higher than the rate in the "fore period." Our results show a mean decrease of 0 9% with a *P.E.* over twice as large as the difference. The two experiments do not agree on this point. But Blatz's graph shows also a later fall below the fore-period rate. It is possible that children pass through this whole cycle more quickly

than do adults, and so this phase of retardation entered into the B-period of our results and obscured the preceding acceleration.

Respiratory-rate. Blatz found a retardation of the rate following the fall. Six of our subjects showed no change, one showed a decrease, and eighteen showed an increase of rate. Here the two sets of results are clearly opposed

Respiratory index (I/E ratio). Blatz found an increase in the ratio after the fall, becoming larger than unity soon after Our subjects also showed an increase in 18 out of 25 cases, but only two of them went above unity. There is a sort of provisional agreement here. Reference to Blatz's graph shows that the I/E ratio kept on increasing until the sixth minute, on the average. At the end of two minutes, 4 out of 20 of our subjects show an increase over the B-period. Here again the two experiments differ in their results

Summing up the above points.

Did the fall cause a real emotion?	Agreement
Pulse-rate change	Disagreement
Respiratory-rate change	Disagreement
I/E ratio change	Agreement
Duration of I/E change	Disagreement

The facts brought out by the above comparison can be interpreted in different ways. It may be, of course, that either or both of the experiments were not conducted correctly We are, perhaps, prejudiced, but we incline to discard this hypothesis. The differences in technique, which seem to be comparatively slight, may in reality be so large as to make the results more different than alike. The number of subjects may be so small that neither set of results is reliable The differences may be due to the use of adults in the one case and children in the other. It is, of course, impossible to say what is the cause of the discrepancies without a great deal more experimentation, but at least one fact has been demonstrated: that there is a need for that repetition of experiments which is sadly lacking in psychology

Correlations between Physiological Changes and Intelligence

Correlations between physiological changes and intelligence as measured by the Stanford-Binet test have been calculated as follows: (*a*) B/A ratios and IQ's, (*b*) deviations of B/A ratios from unity and deviations of IQ's from unity, and (*c*) deviations of ratios from

unity and IQ's as found. The correlations range from almost zero to — 337 and to + 412, none of them being reliable. Correlations were also calculated between the physiological changes and mental age and chronological age, but again no significant coefficients were found

Conclusions

1. The stimulus used, a sudden loss of support, produced a change of the sort usually described as emotional. From our knowledge of the stimulus situation we have called this emotion fear.

2 The stimulus produced.

a A change in the pulse-rate, an increase in 8 cases, a decrease in 13 cases, and no change in 4 cases The average change was a slight and unreliable decrease

b. A change in the respiratory-rate, an increase in 18 cases, a decrease in one case, and no change in 6 cases

c. A change in the mean I/E ratio, an increase in 17 cases, a decrease in 6 cases, and no change in 2 cases The increase rose to a point above unity in only 2 cases

d A rise in the mean amplitude of the pulse-tracing waves in 23 out of 25 cases, indicating a rise in diastolic blood-pressures

e A change in the mean amplitude of the respiratory tracing, an increase in 19 out of 25 cases, seeming to indicate an increase in the total amount of air respired.

f. An increase in the irregularity of the blood-pressure in 20 out of 25 cases, an increase in the irregularity of the breathing amplitude in 10, with a decrease in 15 cases, and an increase in the irregularity of the I/E ratio in 16 cases, with a decrease in 9 cases.

3. An increased change in either direction from unity of the mean inspiration-expiration ratio has usually been accompanied by a change in the irregularity of the I/E ratio.

4 No other relations have been demonstrated between the changes in the physiological activities following the stimulus.

5 The effects produced by the stimulus seem to have disappeared in two minutes in approximately one half of our cases

6 Our results differ from those of Blatz (1) on three out of five counts

7. No relations have been found between the magnitude of the physiological changes and intelligence, mental age, or chronological age

8 The question of children's physiological reactions to an emotional stimulus as compared with the reactions of adults has not been answered in any manner unless the discrepancies between these results and those of Blatz be so interpreted

9 Our lack of definite results may be due to (*a*) the small number of subjects, (*b*) a real absence of the phenomena in point, or (*c*) a faulty technique either in the experimentation or in the treatment of data.

10. Experiments on the physiological reactions of children of school age can be carried on, although under greater difficulties than are encountered with adults

References

1 Blatz, W E The cardiac respiratory and electrical phenomena involved in the emotion of fear *J. Exper Psychol.*, 1925, 8, 109-132.

2 Fantus, B An automatic method of prolonged serial blood pressure registration in man *J Amer Med Asso*, 1917, 68, 1807-1810

3 Koils, A. C Continuous blood pressure tracings in man. an apparatus *J Phar. & Exper Therap.*, 1920, 16, 433-441

4 Landis, C. A method of obtaining records of constant blood pressure *Amer J Psychol*, 1923, 34, 470

5 MacLeod, J J R Physiology and biochemistry in modern medicine 1926.

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UNE ETUDE DES ÉMOTIONS DES ENFANTS SURTOUT À L'ÉGARD DES CHANGEMENTS CIRCULATOIRES ET RESPIRATORIES

(Résumé)

On a fait asseoir 25 garçons, âgés de 7 à 12 ans, sur une chaise spécialement construite laquelle on a laissée tomber a l'improviste une distance de trois à quatre pouces. Leurs réactions ont été mesurées avec un sphygmomanomètre Erlanger et un pneumographe Sumner Les résultats de chaque sujet pour la période après le stimulus ont été divises par ses résultats pour la période avant

Aucun changement des activités physiologiques n'a été constant chez tous les sujets, mais les croissances des vitesses et des amplitudes ont été beaucoup plus usuelles que les décroissances. Il paraît que les changements ont disparus en deux minutes dans environ la moitié des cas.

On a calculé des corrélations entre la quantité du changement à un égard et la quantité à d'autres égards, mais on n'a trouvé aucun rapport constant sauf ceci· un changement de l'un ou de l'autre côté de la proportion moyenne de l'inspiration et de l'expiration a ordinairement été accompagné d'un changement dans l'irrégularité de celle ci, un coefficient de 0,85±0,04 étant présent.

Ces resultats ne sont pas d'accord avec ceux de Blatz, sauf pour deux sur cinq comparaisons

On n'a trouvé aucun rapport entre l'étendue des réactions mesurées et l'intelligence, l'âge mental ou l'âge chronologique

On a critiqué l'appareil employé et l'on a fait des suggestions pour un pareil travail futur

RAY

EINE UNTERSUCHUNG AN KINDERN, BESONDERS IN BEZUG AUF VERANDERUNGEN DES KREISLAUFS UND DER RESPIRATION

(Referat)

Man liess 25 Knaben, 7 bis 12 Jahre alt, sich neidersetzen auf einen besonders eingerichteten Stuhl der sich unerwartet 3 bis 4 Zoll tief senkte Ihre Reaktionen wurden mittels eines Erlangerschen Sphygmomanometers und eines Sumnerschen Pneumographes gemessen In jedem Fall wurde die registrierte Ziffer fur die Periode nach dem Reiz durch die Ziffer fur die Periode vor dem Reiz dividiert

Es zeigte sich keine Veranderung der physiologischen Vorgange konstant bei allen Versuchspersonen Erhoherung der Schnelligkeiten und Grossen (amplitudes) war aber viel haufiger als Verminderung. Die Erscheinungen scheinen ungefahr in der Halfte der Falle nach zwei Minuten verschwunden zu sein

Es sind Korrelationen berechnet worden zwischen dem Umfang der Veranderung in einer gewissen Beziehung und der Veranderung in anderen Beziehungen Es zeigte sich aber kein zuverlassiges Verhaltniss ausserhalb der Tatsache, dass eine Veranderung der mittleren Verhaltnisszahl zwischen Einatmung und Ausatmung (the mean inspiration-expiration ratio) in der einen oder der anderen Richtung gewohnlich mit einer Veranderung der Unregelmassigkeit dieser Zahl einherging Es bestand ein Koeffizient von 85 ± 04

Diese Befunde stehen in Bezug auf nur zwei der funf Vergleichungen mit den Befunden von Blatz in Einklang Man fand kein Verhaltniss zwischen dem Umfang der gemessenen Reaktionen und Intelligenz, geistigem Alter, oder chronologischem Alter

Das Apparat das gebraucht wurde wird kritiziert, und es werden einige Vorschlage gemacht zu Gunsten kunftiger Arbeit

RAY

THE ABILITY OF PRESCHOOL CHILDREN TO SOLVE PROBLEMS IN WHICH A SIMPLE PRINCIPLE OF RELATIONSHIP IS KEPT CONSTANT*[1]

From the Iowa Child Welfare Research Station, State University of Iowa

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In many situations in life, as well as in scientific investigations, the solution of a particular problem depends on the individual's ability to see and to apply a principle of relationship. It was with the purpose of studying this ability in preschool children that the following study was undertaken. More specifically, the aims of the study were: (*a*) to investigate the ability of preschool children to discover the solving principle in problems in which a simple relationship between an object and the means of obtaining the object was kept constant, and to apply the principle in a simple experimental situation, (*b*) to find out to what extent such an ability is related to mental and chronological age. If a child, in solving two problem situations, discovers a principle applying to both, does he apply this same principle in a similar third problem situation?

The children acting as subjects in the experiment were in the preschool laboratories of the Iowa Child Welfare Research Station during 1929 and 1930. In the preliminary study, which was designed to test the feasibility of the method tentatively projected, there were nine children whose ages ranged from two years, two months to nine years. The subjects for the main experiment were 43 children, 23 girls and 20 boys, whose ages ranged from two years to five years, nine months. An attempt was made to distribute the ages as equally as possible over the whole age range from two to five years, inclusive, in order to have a continuous age distribution. Intelligence quotients, 26 of which were derived from the Stanford revision of the Binet-Simon tests and 17 from the Kuhlmann revision, ranged from 91 to 151. The mental-age range, which was somewhat greater than

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[1]This study was directed at the Iowa Child Welfare Research Station by Dr. Ruth Updegraff

the chronological-age range, varied from two years, three months to seven years, five months The chronological age groups were divided as follows. 10 two-year-old children, 10 three-year-old children, 12 four-year-old children, 11 five-year-old children

Apparatus

The apparatus constructed for the study possessed the following characteristics: (*a*) it was simple enough for even a two-year-old child to manipulate, (*b*) everything necessary for the solution of the problem was visible to the child, in other words, the relationship which was the principle of solution was made as apparent as possible, at least from an adult point of view, (*c*) no language responses were necessary as an indication of the child's ability to solve the problems, (*d*) the situations were of enough interest to the child to keep him from becoming bored with repetitions of the experiment

The apparatus consisted of three, small, identical, two-story, gray wooden houses (12 3/4 by 6 inches) with roofs (14 by 5 1/2 inches) The roofs were made of glass (11 5/8 by 3 inches) with wooden borders (1 3/8 inches wide) Each house, divided into three equal compartments, had three doors (3 1/2 by 3 1/2 inches) placed one-half inch apart All three doors were on the same side of the house in order that all of them would be visible at the same time. Dividing each third of each house into two stories was a platform (5 by 3 3/4 inches), so constructed that it could be made to drop when its particular door was opened. On the upper part of the inside of each door was nailed a small piece of metal which protruded one inch at right angles to the door, its function being to hold up the platform when its supporting hook was released These angular pieces were put on all the doors so that there would be no extraneous cue by which the child could tell which door to open

In order to facilitate the changing of the aeroplanes in the houses, the front half of the roof was made to slide on the house by means of a groove A second adjustable device by which the experimental situations could be varied was the slot arrangement for shifting the colors in the doors For this purpose thin strips of wood (1/2 by 1/8 inch) were nailed along the edges of each door to form a frame, and a slot was left at the top into which the colored papers could be slipped. Still another adjustable feature of the apparatus was the front section of the houses which could also be slipped into place by means of grooves.

Procedure

The constant principle of relationship used in the experiment was identity of color between a desirable object and the means of obtaining the object. Three aeroplanes, all of the same color for any one house, were put in the second story of each of the three houses. The three doors of any one house were also of different colors. The hook of the door containing the paper that was the same color as the aeroplane was unfastened so that the platform would drop down and release the aeroplane when the child opened the correct door The other two platforms were kept fastened, consequently, only one aeroplane in each house could be obtained upon the presentation of the house.

When the child entered the testing room with the experimenter, one house was on the table and the other two were on the floor The experimenter seated the child at one end of the table with the house in front of him, taking care that the chair was the right size and that the house was placed so as to make both the aeroplanes and the doors visible She then seated herself at the child's left, with the two houses on the floor beside her, and gave the following instructions: "This house has three doors; all of them open, but only one door makes an aeroplane fall You open one door and see if you can make an aeroplane fall" If the child opened the correct door, he had the privilege of playing with the aeroplane until the experimenter was ready to present another house, but if he opened an incorrect one the experimenter pointed to the door and said, "No, that door doesn't make an aeroplane fall. See, this is the one. This door makes an aeroplane fall" She then opened the correct door and the aeroplane fell. The child, in this case, was not allowed to play with the aeroplane, because the motivation to obtain the toy by his own efforts in subsequent trials would soon be lost. In actual trials, the house remained on the table when the child was successful, and he played with the plane while the records of his responses were completed If the subject were unsuccessful, on the other hand, the plane was replaced and the house was removed at once The child was allowed to play with other things in the room until the presentation of the next house.

Two record blanks were used. On one were recorded the door chosen and the time required for the choice as measured by a stopwatch. The latter record was made in seconds and represents in most cases the interval between the end of the instructions and the

child's choice of the door to be opened. (Sometimes the child opened the door before the experimenter finished her instructions; the time in these instances represents the interval between the beginning of the movement and the touching of the door to be opened.) On a second blank the child's behavior during the period when instructions were given, the method of solving the problem, responses made to the aeroplanes and the house, responses to the experimenter's opening the correct door, the child's behavior when he was successful, and his behavior when he was unsuccessful were checked.

The standard number of trials for each subject per day was nine, but there could be any number of trials from five to ten, inclusive. The criterion of success, five correct successive trials, was arrived at by determining the chances that any one door would be opened a given number of times in succession. Each child was given as large a total number of trials as were necessary for him to learn to open the correct door five times in succession. Whenever possible, children were taken for tests on successive days. There were three series designated as learning series, Series I, II, and III. The houses were presented with red aeroplanes for nine trials a day until success had been attained five times in succession. This constituted Series I. In like manner, the houses were presented with blue aeroplanes and then with green aeroplanes. Following the three learning series, a check series, Series IV, consisting of nine trials, was given, the arrangement being such that each color occurred three times during the series, once in each of the three positions. For example, the red door in the third trial was in position two, in the sixth trial in position one, and in the eighth trial in position three.

On the completion of each of the four series, the subject was asked to point to the door which made the aeroplane fall, to tell without seeing the house which door had made the aeroplane fall, and to explain why that door had been the right one. At the end of the last series an empty house was placed before the child, three aeroplanes of each of the three colors were shown, and the question asked, "Which door did you open to make an aeroplane fall when we played with aeroplanes like these?" The reason for the child's answer was likewise sought.

Analysis of the Results

All the children eventually solved the problems, the trials varying in Series I from 0 to 113 trials, in Series II from 0 to 112, and in

Series III from 0 to 121. There was a variation in the number of correct choices in Series IV from one to nine, nine being a perfect performance. Eleven of the 43 children made nine correct choices in Series IV, which indicated that they comprehended and applied the particular principle upon which the problems were based. Five children made only one error in the check series. Twelve children made from one to three correct choices in Series IV, among them being the second youngest and the oldest child in the whole group of 43.

Results obtained when the children were divided into chronological-age groups are presented in Table 1. The two-year-old children needed approximately the same number of trials in each series. In the other three age groups there was a decrease in the number of trials from Series I to Series III, indicating that responses in Series III were made in respect to learning that took place in Series I and II. In all of these groups, individual variations occurred which are obscured by the mass results. For instance, two of the two-year-old children took no learning trials in Series III. Again, eight of the

TABLE 1

MEANS AND STANDARD DEVIATIONS OF NUMBER OF TRIALS IN SERIES I, II, AND III AND NUMBER OF CORRECT CHOICES OUT OF A POSSIBLE NINE IN SERIES IV ACCORDING TO CHRONOLOGICAL- AND MENTAL-AGE GROUPS

Age, years	Number of children	Trials						Correct choices	
		Series							
		I		II		III		IV	
		Mean	S D	Mean	S D	Mean	S D	Mean	S D
Chronological age									
2	10	36.3	38.16	33.8	37.38	36.7	40.78	4.1	1.06
3	10	22.9	28.58	12.9	12.50	1.2	1.17	4.8	3.22
4	12	14.3	10.23	9.8	11.49	3.2	4.88	6.2	2.67
5	11	14.0	25.23	10.2	16.61	2.8	7.36	6.7	2.57
Mental age									
2	3	48.3	33.84	66.0	39.91	93.0	23.15	4.0	0.00
3	12	20.5	30.73	17.2	18.99	7.9	10.43	3.4	1.61
4	10	33.4	28.47	13.9	12.27	3.5	5.10	5.8	3.06
5	13	12.1	23.85	10.9	14.89	3.0	6.78	6.7	4.83
7	4	8.0	5.09	2.3	1.63	0.0	0.00	7.5	2.59

five-year-olds were below the average for their group, a situation explained by the fact that one member of the group required 92 trials.

Fisher's (1) formula was applied to the data to determine whether or not there was a significant difference between the means of the number of trials taken in each of the series by each of the age groups. Not even a tendency toward significance was found between any series for two-year-old children. This means that for this group, as a whole, each series was responded to as a new situation; only two of the individual cases were an exception to this statement. The differences between the means of trials for the three series for the four- and five-year groups were not significant, probably due to the fact that their initial performances did not allow much room for improvement.

A comparison by series was made of the differences between the average number of trials taken by each chronological-age group. In all three series the differences between performances for four- and five-year-old children were not reliable, P in each case being .8 or higher, indicating that the four- and five-year-old children represent the same population if so small a number of cases will permit any conclusions to be drawn. In Series I (Table 2) no differences were absolutely significant or not significant (P being between .5 and .05) except for ages four and five years, which, as mentioned above, were definitely not significant. For Series II the only significant differences were between two- and four-year-olds, and differences on the border-line existed between two- and five-year-olds. In Series III the differences between the average number of trials required by two-year-old children and three-, four-, and five-year-old children were significant. The difference in the average number of correct choices in Series IV was significant between two- and four-year-olds, and two- and five-year-olds, but not for any other age groups. Consecutive age groups, two and three, three and four, four and five, show no significant differences, although the differences between three- and four-year-olds and three- and five-year-olds approach significance.

In order to find out whether there was any relation between the number of trials taken to learn a series and chronological age, Pearson coefficients of correlation were computed. There were no significant correlations for Series I or II. A correlation of $-.63 \pm .098$ between number of trials on Series III and chronological age existed for the group given the Kuhlmann test (17 cases ranging in age from 24 to 44 months). The Binet group (26 cases ranging in age from

TABLE 2

STANDARD ERRORS OF DIFFERENCE, t, n, AND P WHEN MEANS OF TRIALS BY TWO-, THREE-, FOUR-, AND FIVE-YEAR-OLD CHILDREN ARE COMPARED FOR SERIES I, II, III, AND IV

Ages compared	Standard error of difference	t	n	P
Series I				
2 and 3	16 003	.837	18	4
2 and 4	11 93	1 93	20	between .1 and 05
2 and 5	14 61	1 52	19	between 2 and 1
3 and 4	9 21	939	20	between 4 and 3
3 and 5	12 31	722	19	between 5 and 4
4 and 5	8 13	031	21	9
Series II				
2 and 3	13 07	1 59	18	between 2 and 1
2 and 4	11 83	2 03	20	05
2 and 5	13 04	1 81	19	between 1 and 05
3 and 4	5.32	592	20	between .6 and 5
3 and 5	6 78	401	19	between 7 and .6
4 and 5	6.07	071	21	9
Series III				
2 and 3	13.53	2 62	18	between 02 and 01
2 and 4	12 33	2 71	20	between .02 and 01
2 and 5	13 12	2 58	19	02
3 and 4	1.64	1.22	20	between 3 and 2
3 and 5	2 47	655	19	5
4 and 5	2.65	143	21	between 9 and .8
Series IV				
2 and 3	1 13	619	18	5
2 and 4	.94	2 202	20	between 05 and 02
2 and 5	.92	2 84	19	01
3 and 4	1 31	1 04	20	3
3 and 5	1.33	1.44	19	between 2 and 1
4 and 5	1 13	.486	21	between 7 and .6

42 to 69 months) correlated only —.03±.128 on the same series. Such a correlation for these older children may indicate again that, in general, the performance of four- and five-year-olds is not different A significant correlation of —49± 078 was found when both of the above groups were considered as a whole. Correlations for Series IV indicate that the older children made more correct choices than the younger ones, the correlation for the group as a whole in this case being 51±.070

Coefficients of variation computed for chronological-age groups had no consistent tendencies. The subjects were too few for general conclusions, but, for those tested, the variability in number of trials in each series for each age group was very high. For example, one five-year-old in Series III had 26 trials, which for this particular group of children was an extremely high number, for there were 7 of the 11 children in the group who had no learning trials at all in this series.

Treatment similar to that used with chronological-age groups was applied to mental-age groups (Table 3) Such groupings may not be

TABLE 3

STANDARD ERRORS OF DIFFERENCE, *t*, *n*, AND *P* WHEN MEANS OF TRIALS ON SERIES I, II, AND III ARE COMPARED WITHIN MENTAL-AGE GROUPS OF TWO-, THREE-, FOUR-, FIVE-, AND SEVEN-YEAR-OLD CHILDREN

Series compared	Standard error of difference	*t*	*n*	*P*			
		Mental age					
		2 years					
I and II	42 64	402	4		.7		
I and III	33 41	1.035	4	between	.4	and	.3
II and III	37 62	.717	4		.5		
		3 years					
I and II	34 28	.096	22		.9		
I and III	30.79	.409	22	between	.7	and	.6
II and III	20 56	.452	22	between	7	and	6
		4 years					
I and II	10 28	1.89	18	between	1	and	05
I and III	9 59	3.11	18		01		
II and III	3 66	2 84	18		01		
		5 years					
I and II	7 85	152	24	between	9	and	8
I and III	6 92	1 315	24		2		
II and III	4 57	1 72	24		1		
		7 years					
I and II	3 14	2 15	6	between	1	and	05
I and III	2 99	2 67	6	between	05	and	02
II and III	96	1 312	6	between	3	and	2

valid because the mental ages were derived from two different tests, but, since no other basis for the formation of groups was possible, it has been used in spite of this weakness. Grouping similar scores from the two tests together, then, we find that the three children at the two year–mental-age level increased their average number of trials from Series I to Series III For all other mental-age groups the average number of trials decreased from series to series.

Standard errors of difference were computed to determine whether there were real differences between means of trials on the different series for mental-age groups The differences between series for two- and three-year groups were found to be not significant. Significant differences existed between Series I and II and Series II and III for four-year–mental-age children. No statistically significant differences between series were found for the five-year group, but the actual averages showed a marked decrease in the number of trials required in Series III. Six of the 13 children succeeded immediately in Series III without any preliminary trials Eleven of the 13 children were below the average for that series. One child with 26 trials in Series III increased the average of the group. For the seven-year–mental-age group a significant difference occurred between Series I and III In general, subjects with a mental age above three years required fewer trials in Series III than in Series I and II

Mental-age groups were also compared according to the mean number of trials per series. These comparisons revealed no significant differences between any mental-age groups in Series I, although the chances are between 90 and 95 out of 100 that a difference exists between the two- and five-year groups and the four- and five-year groups Series II showed significant differences for two- and three-year–mental-age children, two- and four-year, and two- and five-year. The differences in mean mental age for two and seven years and four and seven years approached significance In Series III significant differences were found between the two-year group and all the other ages, and the chances are more than even that there were real differences between all the groups that were compared except the difference between the four- and five-year groups. Significant differences were found between three- and four-, three- and five-, and three- and seven-year-olds in Series IV (Table 4).

Coefficients of variation for mental-age groups were computed and showed no consistent trends. The Pearson coefficients of correlation were also determined Series I had no significant correlation with

TABLE 4
STANDARD ERRORS OF DIFFERENCE, t, n, AND P WHEN MEANS OF TRIALS FOR CHILDREN WITH MENTAL AGES OF THREE, FOUR, FIVE, AND SEVEN YEARS ARE COMPARED FOR SERIES I, II, III, AND IV

Mental-age groups compared	Standard error of difference	t	n	P
		Series I		
2 and 3	22 57	1 231	13	between .3 and .2
2 and 4	22 24	669	11	between 6 and .5
2 and 5	18 63	1 943	14	between 1 and 05
2 and 7	23 31	1 299	5	between 3 and 2
3 and 4	13 24	.974	20	between 4 and 3
3 and 5	11 45	.733	23	between 5 and 4
3 and 7	16 22	770	14	between .5 and .4
4 and 5	11 13	1.91	21	between 1 and 05
4 and 7	15 43	1 64	12	between 2 and 1
5 and 7	12 84	.319	15	between 8 and 7
		Series II		
2 and 3	18 50	2.63	13	02
2 and 4	17 53	2 97	11	between 02 and 01
2 and 5	16 38	3 36	14	01
2 and 7	27 21	2 38	5	between 1 and 05
3 and 4	7 24	469	20	between .7 and 6
3 and 5	7.12	.898	23	.4
3 and 7	9 99	1 59	14	between 2 and 1
4 and 5	5 92	507	21	between .7 and .6
4 and 7	6 63	1 908	12	between 1 and 05
5 and 7	9.97	1 21	15	between .3 and 2
		Series III		
2 and 3	10.50	8 10	13	01
2 and 4	9.67	9 15	11	.01
2 and 5	8.91	10 10	14	.01
2 and 7	13 77	5 89	5	.01
3 and 4	3 75	1 17	20	between .3 and 2
3 and 5	3.65	1.34	23	between 2 and 1
3 and 7	5 48	1 44	14	between .2 and .1
4 and 5	2 62	1 90	21	between 9 and 8
4 and 7	2 74	1 27	12	between .3 and 2
5 and 7	3 62	828	15	4
		Series IV		
2 and 3	99	606	13	between .6 and 5
2 and 4	1 91	946	11	between .4 and .3
2 and 5	1 33	2 03	14	between .1 and .05
2 and 7	1 77	1 97	5	between 2 and 1
3 and 4	1 06	2 26	20	between 02 and 01
3 and 5	809	4 07	23	01
3 and 7	1.15	3 57	14	.01
4 and 5	1.12	803	21	between 5 and 4
4 and 7	1 87	.909	12	between 4 and 3
5 and 7	1 41	567	15	between 6 and 5

mental age. In Series II a correlation of —.39±.087 was found when the whole group of 43 children was used, a slight indication that children with higher mental ages tended to take fewer trials on Series II. Correlations in Series III between mental age and number of trials are similar to those in Series III for chronological age and number of trials. For example, the correlation for the Kuhlmann group was —.61±.101; for the Binet group, only —.09±.128, and for the group as a whole, —.51±.076. In Series IV there was some tendency for the number of correct choices to increase with mental age, the total correlation for this series being .662±.087.

It will be remembered from the discussion of the relationship between chronological age and Series III that the same type of correlation occurred there. It was suggested that chronological age was a possible factor influencing the performance of two- and three-year-old children, but that chronological age did not account for the performance of four- and five-year-old children, that is, that there was a difference between the performance of two- and three-year-olds but that any child above the age of three-and-a-half was as likely to take a small number of trials in Series III as was any other child. Since the same type of relationship is indicated between mental age and Series III, it is rather difficult to draw any conclusions as to which factor is more influential in conditioning performance. Since the number of cases is too small for partial correlations, no conclusions can be made as to the relative importance of chronological and mental age in influencing performance on this test.

Analysis of Choices on the Basis of Color and Position. The number and percentage of times each color and each position was chosen in each series within each age group were determined, but the procedure did not lead to an understanding of how the children finally attained success. In general, it was found that those children who took many trials repeatedly selected the same position and color, though it cannot be inferred that the child repeating his choices necessarily learned more slowly than the others.

The number of times each color was the first choice in each series gives more useful results than the above method. This is shown by the facts that 30 of the 43 children opened the red door first when they began on the second series (where blue is the correct color) and that 14 of them chose blue on their first trial in Series III, while 21 chose green, the correct door.

Case studies add further to our knowledge of the child's procedure

by revealing two ways of arriving at success. The child could respond to one specific detail of the total situation, i e., to a door of a given color, or he could respond to a door of a given color in relation to aeroplanes of a given color. Both types of response were to a detail or details in relation to a total situation, but the whole in each case was different

Study of these case records also shows that not all the children could correctly name the three colors used. Thirty of the 43 named red correctly, one called the red aeroplane blue, and 12 made no remarks about red Twenty-nine used blue correctly, 12 made no mention of it, and 2 used it incorrectly. Thirty-three indicated green in the right connection, 3 used it incorrectly, and 7 omitted mention of it To test further the child's reactions to color, a color-matching experiment with the nine aeroplanes was conducted. Practically all the failures resulting were found in the two-year group, only one of these children being successful One three-year-old child failed with all three colors, and one three-year-old failed to select the blue ones correctly.

Discovery of the Principle. In order to find out whether there was a tendency for the children who took many learning trials in Series I to continue doing so in the other two series, coefficients of correlation between the series were computed, the Pearson formula being used for all but Series III and Series IV in which case the bi-serial r, as given in Kelley, (2, pp. 245-249), was computed The number of trials in Series IV accountable by chance was determined and found to be 3 ± 95 The distribution for this series was therefore dichotomized at seven. The correlations follow:

Series	r	*P E*
I and II	36	± 088
I and III	32	± 092
II and III	68	± 055
III and IV	35	± 118

The only significant correlation is between Series II and III This indicates that for the group as a whole there was a tendency for children to take the same number of trials in Series II as in Series III

A group of 16 children who took no learning trials in Series III were studied with respect to their performance in the other series

These records were tabulated in order of age, two being in the two-year group, two in the three-year group, five in the four-year group, and seven in the five-year group. One three-year-old child required 65 learning trials in Series I, while 10 children had from zero to four trials Twelve children took four trials or less in Series II Although all the children immediately solved Series III, only nine made perfect performances in Series IV and two others made eight correct choices With one exception, it was the younger children who failed to get the check series right

The assumption cannot be made that, if a child solved Series III without any learning trials, he had discovered the principle to the extent that he could apply it in Series IV Immediate solution in Series III did not necessarily mean nine correct choices in Series IV This lack of relationship may indicate that Series IV was not a valid check series, or it may indicate that a child may learn to respond correctly in one situation and still not be able to apply a principle in a situation which, to an adult, at least, is similar to the learning situation

Two other groups were studied, those who made nine correct choices on Series IV and those who made only one to three correct choices, to find out if there were differences between the two groups in the average number of trials for the various series. No two-year-old child was entirely successful in Series IV. Two three-year-olds, three four-year-olds, and six five-year-olds successfully completed the series. All children who made either no errors or only one error in the check series had a mental age of four years, three months, or above. The range of intelligence quotients for the group was 94 to 151 The group with not more than three correct choices contained the second youngest and the oldest child in the group, had a mental-age range of two years, three months, to seven years, and an intelligence quotient range of 91 to 146. There was definitely no difference between the number of trials for the two groups in Series I or II, but the children succeeding in the check series tended to take fewer trials in Series III than did the others The reverse relationship between Series III and IV did not necessarily hold, that is, not every child who had no learning trials in Series III made nine correct choices in Series IV.

A further attempt to account for success involved a study of the qualitative records The items compared were:

1. Jerks open door without inspecting.
2. Jerks open door after inspecting.
3. Looks at all doors before opening one
4. Looks at aeroplanes
5. Opens door slowly.
6. Opens one door without touching others.
7. Touches one door besides the one opened
8. Touches two doors besides the one opened
9. Touches three doors before opening one.
10. Makes movement toward door
11. Makes movement toward another door after opening wrong one

No significant differences were found on any items between the groups which were and were not successful in Series IV.

The data also revealed that no child under three years, four months of age, indicated by remarks that he perceived the relationship between the color of the door and the color of the aeroplane. Seventeen children, all above three years, four months of age, indicated this relationship for the red series, 19 for the blue, and 20 for the green Every child successful in Series IV mentioned the relationship, though many who mentioned the colors did not succeed on this test. The 43 children could be put roughly in the following categories:

1. Children who learned to solve the problems but who made no remarks about the doors and aeroplanes *matching, or about the color of either*
2. Children who said that a door of a certain color made the aeroplane fall No reference was made to the color of the aeroplanes
3. Children who said that the aeroplanes were a certain color and that the doors were a certain color but who did not relate the two
4. Children who stated that a door of a certain color made an aeroplane of a certain color fall but who made no application in Series IV.
5. Children who were not successful in Series IV but who at the end of it chose the correct doors for the correct aeroplanes.
6. Children who stated the relationship and applied it in Series IV

In general, there were two types of solution, immediate and deferred. Immediate solutions were those in which there were no learning trials; deferred solutions were those in which there were

learning trials. Not all of the cases, however, that were called deferred required the same number of trials to arrive at the solution, for a deferred solution could take place after the second, the tenth, the hundredth, or any other trial Whether the solution to the problems came as a gradual process or at one point is difficult to say from the objective results, it was the experimenter's subjective opinion that a few of the children seemed to discover the solution all at once Immediate solutions increased with each series, there being only one in Series I, two in Series II, and sixteen in Series III.

Summary

The study represents an investigation of the ability of preschool children to discover a particular principle of solution in problems in which a simple relationship between an object and the means of obtaining the object were kept constant in similar situations. The problem consisted in discovering which one of three doors in a toy house released a toy aeroplane. The relationship employed was similarity of color between the aeroplane and the correct door. Forty-three children, ranging in age from two years to five years, nine months, were subjects in the main experiment.

The results of this study are

1. Every child sooner or later solved the problems, although not all of them discovered the principle upon which the problems were based.

2. In general, two-year-old children did not improve from the first to the last series; but children of other ages did improve, indicating that they had profited by the experience of solving the previous series. A correlation between chronological age and number of trials indicated some degree of relationship between chronological age and performance, but there were marked exceptions. No two-year-old child was successful in Series IV, the check series A correlation between chronological age and number of correct choices in the check series indicated that with increasing age children tended to discover the particular principle upon which the problems were constructed

3. For all children with mental ages of three years or more there was an improvement from Series I to III with mental age. With increasing mental age there were fewer trials in the initial series, and an increase in the mean number of correct choices in Series IV.

4 The effect of one series upon another is shown by the fact

that 69% of the children chose the same door in Series II as in Series I, but in Series III children above the age of two tended to choose on the basis of the relationship between the color of the door and the color of the aeroplanes.

5. The correlation between Series III and IV indicates either that Series IV is not a reliable check series or that success in Series III does not necessarily mean success in Series IV

6. The youngest child who mentioned the relationship between the color of the doors and the color of the aeroplanes was three years, four months old The majority of the children could point to the correct door in each house after each series, and 72% did the same thing after completion of Series IV Most of the failures were for the two-year group.

7 The 43 children were grouped into six categories on the basis of types of response made in regard to the principle of relationship.

8. When the order of choice was examined, it was found that some children seemed to try position, some color, and that the solution took place on both bases of choice The subjects were not systematic in their attack, some using one or the other, and some both.

9. Solutions were designated as immediate, in which there were no learning trials, and deferred. In Series I there was only one immediate solution, there were two in Series II, and sixteen in Series III

References

1 Fisher, R A Statistical methods for research workers (*Biological Monographs and Manuals*, No 5) (2nd ed, rev and enl) London Oliver & Boyd, 1928 Pp xi+269

2. Kelley, T L Statistical method New York Macmillan, 1923 Pp xi+390

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L'HABILETÉ DES ENFANTS D'ÂGE PRÉSCOLAIRE À RÉSOUDRE DES PROBLÈMES OÙ UN SIMPLE PRINCIPE DE RAPPORT RESTE CONSTANT

(Résumé)

Pour étudier l'habileté des enfants d'âge préscolaire à découvrir un principe spécial de solution dans des problèmes où un simple rapport entre un objet et le moyen d'obtenir l'objet est resté constant, on a donné quatre situations de problèmes à 43 enfants d'âge préscolaire, âgés de deux à cinq ans, neuf mois D'une petite maison de bois, de deux étages, ayant trois portes, chacune d'une couleur différente, l'enfant a pu obtenir un petit avion, en ouvrant la porte de la couleur des avions Après trois séries d'apprentissage dans chacune desquelles il s'est agi du même principe, l'identité de couleur de la porte qu'il a fallu ouvrir et des avions, on a présenté une série de contrôle pour trouver si l'enfant a compris le principe de la correspondance des couleurs

Quelques-uns des résultats de l'étude sont.

1. Chaque enfant a resolu les problèmes après quelque temps, bien qu'ils n'aient pas tous découvert le principe spécial à la base des problèmes
2. Pour tous les enfants sauf ceux âgés de deux ans, le nombre moyen des épreuves a diminué de la première serie à la troisième
3. Une corrélation entre l'âge chronologique et le nombre des épreuves a indiqué quelque degré de rapport entre l'âge chronologique et le rendement, mais il y a eu des exceptions frappantes.
4. Avec la croissance de l'âge, il y a eu une tendance chez les enfants à découvrir le principe spécial sur lequel on a construit les problèmes.
5. Avec la croissance de l'âge mental, il y a eu peu d'épreuves dans la première série, et une croissance du nombre moyen de choix corrects dans la série de contrôle.
6. On a désigné les solutions comme immédiats, où il n'y a pas eu d'épreuves d'apprentissage, et retardées

ROBERTS

DIE FÄHIGKEIT VORSCHULPFLICHTIGER KINDER ZUR LÖSUNG VON AUFGABEN IN DENEN EIN EINFACHES PRINZIP DER BEZIEHUNG KONSTANT GEHALTEN WIRD

(Referat)

Zur Untersuchung der Fähigkeit vorschulpflichtiger Kinder, ein besonderes Prinzip der Lösung zu entdecken bei Aufgaben in denen eine einfache Beziehung konstant gehalten wurde zwischen einem Gegenstand und der Weise, auf der der Gegenstand erreicht werden konnte, versetzte man 43 vorschulpflichtige Kinder, 2 Jahre bis 5 Jahre 9 monate alt, in vier Situationen, die Aufgaben darstellten. Man errichtete ein kleines zweistockiges Haus mit drei Türen, jede von einer besonderen Farbe Das Kind konnte ein Aeroplanspielzeug dadurch erreichen, dass es die Türe öffnete die die selbe Farbe hatte als die Aeroplanspielzeuge. Nach drei Lernserien, in denen immer das selbe Prinzip—die Identität der Farben an den Aeroplanspielzeugen und an der richtigen Tür—herrschte, wurde eine Kontrollserie dargeboten um zu erforschen, ob das Kind das Prinzip der Farbenübereinstimmung begriffen hatte

Einige Befunde aus der Untersuchung lauten wie folgt.

1 Jedes der Kinder loste fruher odei spater die Aufgaben, obwohl nicht alle das besondere Prinzip entdeckten, worauf die Aufgaben gegrundet wurden.

2 Bei allen Kindern, ausser den Zweijahrigen, verminderte sich die mittlere Zahl der notigen Versuche zwischen der ersten und der dritten Serie

3. Die Korrelation zwischen dem chronologischen [d h. eigentlichen] Alter und der Versuchszahl deutete an, dass eine gewisse Beziehung zwischen dem chronologischen Alter und der Leistung bestand Es gab aber bestimte Ausnamen

4 Bei steigendem Alter erwiesen die Kinder eine Tendenz, das besondere Prinzip zu entdecken, worauf die Aufgaben errichtet worden waren

5 Bei steigendem Altei gab es in der ersten Serie weniger Versuche und in dei Kontrollserie eine Zunahme der mittleren Zahl der richtigen Auswahlen

6. Man bezeichnete die Losungen ohne Lernversuche als unmittelbare unde die ubrigen Losungen als verzogerte Losungen

ROBERTS

DEPTH DISCRIMINATION IN THE RAT*[1]

From the Psychological Laboratories of the University of Chicago

JAMES T RUSSELL

It is the purpose of this study to give evidence of visual depth discrimination in the rat, to determine approximately the threshold of discrimination, and to analyze the mechanisms involved.

LITERATURE

Richardson (4) trained rats to jump from one platform to another to get food. The study consisted of observation of improvement in accuracy at each distance as the distance between platforms was varied up to 30 inches She employed normal, blind, and anosmic animals, a few rats in each group The record consisted of the number of trials required until jumping was facile and a description of the character of jumping at several stages of the process Both distance and direction were altered separately and together.

Richardson's conclusions were the following The visual stimulus apparently afforded a basis for proper control as to the direction in which the jump was to be taken, but failed signally to afford any adequate basis for accommodation to changes in distance only. The visual impressions were not a sufficient control when length of jump was changed, and, after a seeming struggle between visual and kinæsthetic factors, the coordination broke down completely Blind subjects learned to jump considerable distances when first given their orientation Olfactory stimuli were of little importance Kinæsthetic and tactual impulses were of value. These impulses were essential factors in control, not only in the learning process but also in the reactions after they became habitual In jumping, when the conditions were changed after habit became established, the subjects were unable sufficiently to modify the amount of innervation required, and so the reactions were unsuccessful

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Waugh (6) placed mice on a disk, raised it a certain distance above a table, and measured the time that the animals hesitated before jumping when the height of the disk was varied. Nine mice were used. He found that the greater the height the longer the hesitation and so inferred some visual perception of distance. However, when the mice (13 animals) were required to judge which of two partitions was nearer to their starting point and to turn right or left in accordance with that preliminary judgment, they failed. There was no significant difference between albino and black-eyed animals.

Waugh concluded as follows. The distance of objects is perceived within a range of 15 cm. Mice are lacking in retinal cones and in any structurally differentiated area corresponding to the macula in higher forms. The range of vision is very wide, all parts of the retina being equally sensitive. There is possible for the mouse a small field of binocular vision. This is not used for estimating distance, as there is no convergence of the eyes. The kinæsthetic sense is more important than the visual in determining the actions of the mouse.

Vision may play a greater rôle in the perception of depth than the studies of Richardson and Waugh indicate. Their techniques are both open to criticism. Richardson arranged her platform within a uniform visual environment by means of screens so that the possibility of judging distance other than by binocular parallax may have been ruled out by the experiment. The method of Waugh, as Washburn (5, pp. 237-242) points out, involves a rather complex type of learning and therefore may have failed to reveal the actual capacity of an animal in simpler situations.

The work of Lashley (1, 2, 3) demonstrates that rats have a capacity for fine discrimination of visual patterns. Albinos have less acuity than pigmented rats, as measured by reactions to patterns. The threshold of pigmented animals for objects 20 cm. distant from the eye is below 52 minutes and above 26 minutes of arc. The threshold of albinos is from two to four times higher. The threshold of the albino corresponds to the resolving power of the eye, determined by direct measurement.

Apparatus

The apparatus (Figure 1) was designed to measure the force with which a rat jumps from one ledge to another. It consists of

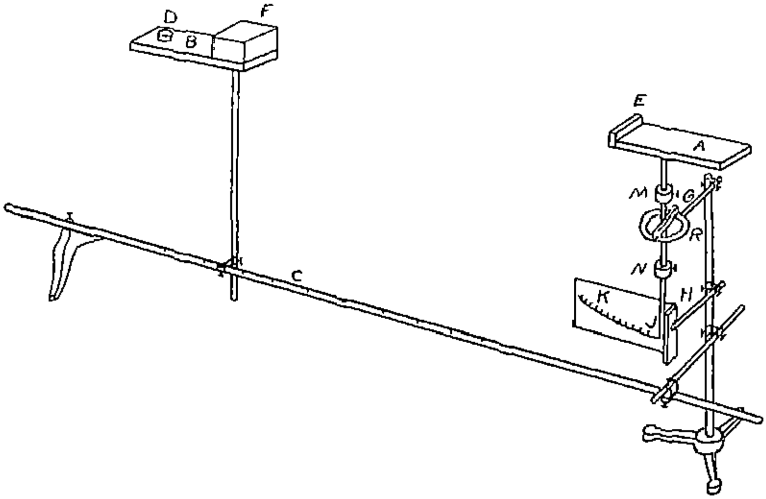

FIGURE 1

DIAGRAM OF APPARATUS

A, jumping platform, *B*, landing platform; *E*, jumping ledge; *F*, landing ledge; *D*, food cup; *M* and *N*, sliding clamps, *G*, knife edge, *R*, ring for knife edge, *H*, back stop, *J*, pointer; *K*, force scale, *C*, distance scale

two platforms, one movable and one fixed, the former being the top of a "Kater's pendulum" The pendulum swings upon the knife edge, *G*, mounted on the ring, *R*. It is adjusted so as to be somewhat in disequilibrium, causing the lower end to press against a rigid backstop, *H*. The rat jumps from the fixed platform, *A*, to the movable platform, *B*. The latter is clamped to a rod, *C*, bearing a centimeter scale. At the far end of the landing platform is a cup, *D*, containing bread and milk The animal is placed upon the platform, *A*, where he grips the narrow jumping ledge, *E*, with all four feet. He jumps to the landing ledge, *F*, topped with felt. The force of jumping causes the pendulum to swing clockwise, the pointer, *J* (the lower end of the pendulum), describing an arc along the scale, *K*, calibrated in grams of force.

The apparatus is very sensitive throughout its force range. Clamps *M* and *N* permit adjustment of the force range.

Dimensions of the apparatus in centimeters. jumping platform, 13 x 9; landing platform, 23 x 12; jumping ledge, 0.7 x 9, elevation above platform, 1; landing ledge, 4.4 x 12, elevation above plat-

form, 4. Both platforms are 80 cm. above the floor. All parts of the apparatus are iron except for the platforms and scale, *K*. The system is quite rigid.

The purpose is to employ difference in force of jumping as a criterion of difference in recognition of depth. We are not concerned with distance jumped and the force required to make the jump, but with the force required to make a jump through a prescribed distance. Also, it should be made clear that, in this experiment, the rat reacts to absolute distance, to a single stimulus. It does not discriminate between two distances.

It may be objected that the apparatus measures only the horizontal component of the force exerted But the trajectory of the rat's jump is nearly horizontal for any distance employed The horizontal component of force is the effective one. Increase in the vertical component, which would be expected for increase of distance, would act to reduce the force as recorded. If we allow for the relatively small part played by the vertical component, the result is to add support to the argument of this paper

Experimental

A. Existence of Visual Depth Discrimination

Adult or nearly adult rats, starved for 24 hours, were used. A preliminary series of 20 to 30 trials was run in the case of each rat At first the distance between ledges was made short enough for the animal to step across and then the distance was increased by 3- to 5-cm. steps to 50 cm. Then a few trials were run at distances chosen at random. After each jump the animal was permitted to take a nibble of bread and milk and then was replaced on the jump-

TABLE 1

Correlation between Force and Distance of Jumping

Individual records for eleven rats of total force in grams of ten jumps at each distance

	Rat										
Distance	*Y*1	*Y*2	*Y*3	*Y*4	*B*1	*B*2	*B*3	*B*4	*A*1	*A*2	*A*3
20	217	235	204	296	190	297	206	458	272	262	296
25	294	296	251	360	300	472	411	489	269	282	369
30	318	366	309	397	409	641	547	532	276	289	414
35	496	371	374	415	506	697	579	524	286	295	471
40	561	397	401	439	564	830	612	567	290	310	456
45	580	426	419	452	597	858	617	566	293	306	464

TABLE 2

THE DATA OF TABLE 1 EXPRESSED IN TERMS OF PERCENTAGE

The force exerted at each distance is expressed in terms of the force exerted at 20 cm Included are the mean values of the yellow-hooded (*Y*) and black-hooded (*B*) groups and the mean values of the albino (*A*) group

Dist.	Rat *Y*1	*Y*2	*Y*3	*Y*4	*B*1	*B*2	*B*3	*B*4	*A*1	*A*2	*A*3	Mean *Y* and *B*	Mean *A*
20	100	100	100	100	100	100	100	100	100	100	100	100	100
25	135	126	123	121	157	168	199	107	99	107	124	142	110
30	192	155	151	134	215	228	265	116	101	110	139	182	117
35	228	158	183	140	266	248	281	114	105	112	159	202	125
40	258	168	196	148	297	297	296	124	106	118	154	223	126
45	267	181	205	153	314	306	299	124	107	117	157	231	127

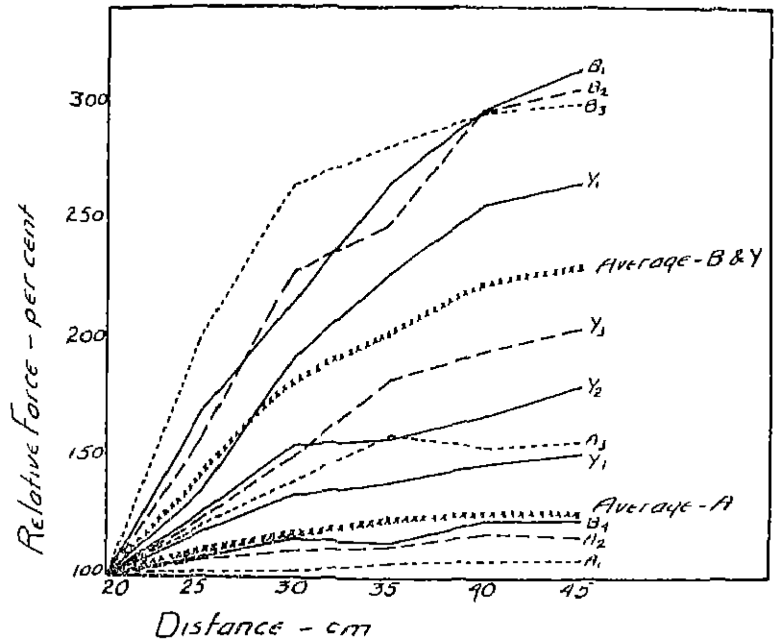

FIGURE 2

CORRELATION BETWEEN FORCE OF JUMPING AND DISTANCE TO BE JUMPED

Individual graphs of 11 rats, together with graphs of average records of the albino (*A*) group and of the black-hooded (*B*), and yellow-hooded (*Y*) group The force scale is relative to the force exerted in jumping 20 cm

ing platform. A considerable amount of urging, with the animal oriented appropriately, was required at first, but usually within the limit of the above number of trials the animal jumped readily enough. In the test series, the distances were kept within range of 20 to 45 cm. Below 20 cm. it was not necessary for the rat to jump and few animals would jump readily a distance in excess of 50 cm. The apparatus was used in the open room with a background of cage racks.

The record consists of 10 trials at each of six distances. The distances, ranging from 20 to 45 cm. by 5-cm. steps, were varied for each rat from trial to trial in chance order. Ten trials were run each day. Table 1 summarizes the data. The numbers represent total force in grams for the 10 trials at each distance. The rats were: four yellow-hooded (*Y*); four black-hooded (*B*), three albino (*A*). Table 2 shows the same data in different form. For each rat the total force exerted at 25 cm., 30 cm., etc., is expressed as a percentage of the total force exerted at 20 cm. The same data are represented graphically in Figure 2. It is clear from these data that force and distance are directly related in the case of every rat. As distance increases the force of jumping increases. In general, the curves are negatively accelerated. Inclusion of the vertical component of force might cause the degree of deceleration to be less. Two mean curves are shown. The curve "Average—*B* and *Y*" is the mean curve of the eight rats with pigmented eyes. The curve "Average—*A*" is the mean curve of the three albino rats. Comparison of these mean curves suggests that rats with non-pigmented eyes may be much inferior to rats with pigmented eyes.

Richardson concluded that preliminary trials are required upon changing the distance in order to establish accurate jumping. The evidence here is against such a conclusion. Preliminary trials are not necessary for adjustment of force to distance to be jumped. The view that the rat first jumps with a random variation of force and can adjust for a given distance only after a series of jumps at that distance seems unwarranted. In the present experiment, the distances were varied from trial to trial by chance so that adjustment to a given distance by learning was ruled out. Immediately upon changing distance, the rats accommodated for the change by a change of force. These results strongly suggest that vision is an important factor in identification of depth.

The high correlation found between force exerted and distance

to be jumped, where distance was varied in a chance order, suggests that vision is the only probable cause of change of force in the present case. *Olfaction and audition may be offered to explain the* results. But it seems impossible for audition to play a part In the present experiment, both platforms soon became smeared with excrement and food particles so that the odors from the jumping platform were probably intense enough to swamp what would otherwise be a difference in olfactory cues. Richardson concluded that olfaction is unimportant. Other evidence, discounting the possible rôle of olfaction, is offered later.

Indirect evidence of the rôle of vision may be found in the apparent difference between rats with pigmented eyes and rats with non-pigmented eyes. Two of the three albinos were least accurate of the eleven animals in depth discrimination. The third albino performed better than two rats with pigmented eyes, although his record was considerably below the average of the entire group. The curve of this rat fails to rise for distances beyond 35 cm.

In Table 3 are recorded the number of jumps at each distance and the total number of jumps in which the rat fell short of the landing ledge No animal fell short of 30 cm. It is to be remembered that each rat made 10 jumps at each distance. It is obvious that the albinos are all much inferior to the rats with pigmented eyes. Rat *A*3, who had a creditable performance as measured by the correlation between force and distance, is here no better than the other albinos. These results strengthen the suggestion made above that degree of pigmentation of eye is directly correlated with ability to discriminate depth.

Table 4 contains the mean deviations of the data in Table 1, also the mean of the mean deviations of the rats with pigmented eyes and of the rats with non-pigmented eyes. It appears that variability

TABLE 3

THE NUMBER OF "SHORT" JUMPS AT EACH DISTANCE IN THE CASE OF EACH RAT, TOGETHER WITH THE TOTAL NUMBER OF "SHORT" JUMPS OF EACH RAT

Only distances at which short jumps were made are recorded.

	Rat										
Distance	*Y*1	*Y*2	*Y*3	*Y*4	*B*1	*B*2	*B*3	*B*4	*A*1	*A*2	*A*3
35	0	0	0	0	0	0	0	0	2	1	1
40	0	0	0	0	0	0	0	0	8	3	6
45	0	0	0	1	0	0	3	4	10	8	8
Total	0	0	0	1	0	0	3	4	20	12	15

TABLE 4

THE MEAN DEVIATIONS OF THE DATA OF TABLE 1, TOGETHER WITH THE AVERAGE MEAN DEVIATIONS OF THE YELLOW- AND BLACK-HOODED GROUPS AND OF THE ALBINO GROUP

Dist	Rat *Y*1	*Y*2	*Y*3	*Y*4	*B*1	*B*2	*B*3	*B*4	*A*1	*A*2	*A*3	Mean *Y* and *B*	Mean *A*
20	2.2	2.6	0.9	2.5	1.4	3.4	4.7	5.1	1.9	4.1	3.3	2.9	3.1
25	5.1	1.9	2.1	1.5	1.2	4.4	6.9	2.9	1.1	4.1	3.7	3.3	3.0
30	2.7	2.6	4.6	1.8	2.0	3.7	6.4	4.3	1.6	2.9	4.1	3.5	2.9
35	5.0	2.9	1.7	2.3	2.6	10.0	5.7	3.6	1.6	3.0	4.8	4.2	3.1
40	5.3	4.7	3.3	2.1	2.4	4.8	7.5	4.6	1.1	2.8	4.2	4.3	2.7
45	5.8	4.8	3.4	3.6	3.0	7.4	5.8	4.8	1.6	2.3	4.5	4.8	2.8

of force increases regularly with increase of distance for the former group, and that there is no such definite relation for the latter group. In general, the greater the distance the greater is its ambiguity. These data would be treated with finer statistics were it not for the small size of the albino group

A regular ascending series of distances, followed by a descending series, was run for rat *Y*2 Each day eight trials were run for each distance The force for each distance is the average of 96 trials. Because of several accidental changes of calibration of the apparatus (discovered later) only averages are recorded in Table 5. Comparison of these data with those of Table 2 indicate that discrimination was possibly better in the present case in which the additional

TABLE 5

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR ONE RAT

In the ascending series the distances were increased regularly; in the descending series the distances were decreased regularly The force measures are the averages of 16 consecutive trials at each distance

Ascending series Dist	Force	Percentage Force	Descending series Dist	Force	Percentage Force
20	22.7	100	50	52.4	266
25	28.6	126	45	51.6	262
30	37.7	166	40	45.6	231
35	45.0	198	35	38.6	196
40	51.7	227	30	32.6	165
45	60.3	265	25	25.4	129
50	66.3	292	20	19.7	100

factor of habituation entered. A study of this factor will form part of the material of a future paper.

It seems clear from the correspondence of force exerted with distance to be jumped and from the difference between rats with pigmented and rats with non-pigmented eyes that, contrary to the findings of Richardson, the rat is able to discriminate distances visually and to regulate his motor reactions accordingly without having to adjust to each new distance by a process of trial and error

B. Threshold of Depth Discrimination

The following method was employed to secure a crude approximation to a "depth threshold" under the conditions outlined above Instead of varying the distances by 5-cm. steps in a chance order, the distances were varied in a chance order by 1-cm. steps throughout a range of 26 to 36 cm. Twelve trials were run for each distance This procedure was followed for rats with pigmented eyes. For albinos it was found convenient to vary the distances by 2-cm steps throughout a range of 22 to 42 cm. The total force at each distance for each rat was found Then, in the case of each pigmented rat, the successive differences in force between each distance and the next succeeding distance were determined These represent differences in force corresponding to differences in distance of one cm The same thing was done for the successive 2-cm steps The corresponding differences for albinos are for 2- and 4-cm. steps,

TABLE 6

THRESHOLD DETERMINATION

Individual records for eleven rats of correlation between force and distance of jumping The force measures are the averages of 12 trials at each distance.

Dist.	Rat Y1	Y2	Y3	Y4	Y5	Y6	B1	B2	Dist.	Rat A1	A2	A3
26	201	261	166	562	437	322	244	433	22	112	181	158
27	190	271	181	561	453	333	262	443	24	108	194	198
28	212	292	190	551	437	330	281	469	26	133	204	224
29	228	298	199	584	428	334	297	458	28	143	216	226
30	225	314	211	619	459	331	310	500	30	135	219	252
31	231	314	198	583	454	325	328	462	32	148	227	241
32	242	327	216	579	445	349	319	485	34	146	214	277
33	236	314	215	589	458	341	350	463	36	149	227	272
34	251	340	227	570	459	354	374	458	38	155	246	311
35	251	335	236	601	463	329	373	481	40	163	239	349
36	270	370	240	609	488	346	396	505	42	163	240	332

TABLE 7

THE NUMBER OF "INVERSIONS OF SIGN" FOR 1-CM, 2-CM, ETC, DIFFERENCES IN DISTANCE FOR EACH RAT OF TABLE 6

The number of inversions of sign is the number of cases in which the force exerted at a given distance is less than the force exerted at a distance 1 cm, 2 cm, etc., less than the given distance See text

Rat	Inversions 1 cm	2 cm.	3 cm.	4 cm
*Y*1	2	0	0	–
*Y*2	3	0	0	–
*Y*3	2	1	0	–
*Y*4	5	4	3	–
*Y*5	4	2	2	–
*Y*6	5	3	3	–
*B*1	2	0	0	–
*B*2	4	2	3	–
*A*1	–	3	–	0
*A*2	–	2	–	2
*A*3	–	3	–	0

respectively. Table 6 is a record for each rat of the total force of 12 trials at each distance

The number of inversions of sign was calculated for each animal That is, the number of differences indicating a decrease in force in going from each distance to the next greater distance was determined and designated as the number of inversions of sign Such inversions indicate failure of depth discrimination as determined by the criterion of force Table 7 is a record for each rat of the number of inversions for 1-, 2-, 3-, and 4-cm differences.

In case of absence of discrimination the number of inversions should equal, in the long run, one-half of the number of differences in the distance range, i e, for rats with pigmented eyes the number of inversions would be 5, 4 5, and 4, for 1-cm, 2-cm, and 3-cm differences, respectively, for albino animals the values would be 5 and 4 5, for 2-cm and 4-cm differences, respectively For example, there are 11 different distances. Hence, there are 10 1-cm steps So, for 1-cm differences or steps, random force of jumping would result in five inversions No inversions indicates that all steps in the distance range are discriminated correctly on an average of 12 trials at each distance

Although the group of albino rats is small, the data suggest that the albino rats are much inferior to the rats with pigmented eyes in respect to sensitivity of response to change of depth as measured by

change of force of jump. The albino rats are also inferior to the rats with pigmented eyes in respect to the number of short jumps. The total number of short jumps made by three albino rats was 17, 11, and 3 for rats *A*1, *A*2, *A*3, respectively. Rats *Y*1, *Y*2, *B*1, *B*3, and *Y*3 made no short jumps; *B*2 made one, *Y*4 made two, *Y*5 made five, and *Y*6 made eight

*Y*1, *Y*2, and *B*1 always discriminated a difference of two cm on an average of 12 trials The record of *Y*3 was nearly as good. However, the other rats with pigmented eyes did not always discriminate differences of three cm. Two albinos discriminated successfully differences of four cm, and one did not. Inspection of Table 2 shows that no rat with pigmented eyes had any inversions for 5-cm steps, whereas the albinos each had one inversion.

To determine how the inversions were distributed over the distance range in the case of the pigmented rats, the total number of inversions for 1-cm. steps for the group of eight animals was determined and recorded in order of increasing distance. They are

3 2 3 1 5 3 5 2 2 0

It had been noted that there were no pronounced trends in the case of individual rats The group data do not show any significant differences in accuracy of discrimination over the distance range in question. The data of Table 6 have been converted into percentages of the force exerted at the initial distance according to the method of treatment of Table 1. The percentages have been averaged for the group. They are in order of increasing distance

100 103 107 111 115 113 117 117 121 122 128

Only one inversion of sign resulted from the pooled data

By the method of computing threshold of visual discrimination of distance, it is found that rats with pigmented eyes can distinguish with a fair degree of accuracy differences in distance of two cm. or less, whereas rats lacking pigmentation of eyes do not have such accuracy.

C. *Mechanism of Visual Depth Discrimination*

It seems certain that vision is the most important sensory avenue involved in identification of depth in the present experiment.

Some of the possible factors involved in visual depth discrimination of the rat may be: accommodation, convergence, binocular parallax, monocular parallax, aerial perspective (intensity, texture,

etc., of features of the jumping platform and background fixated), geometrical perspective (position of features fixated in reference to the background and the size of the retinal image).

Accommodation Accommodation to the distances required for jumping seems rather conclusively ruled out by the myopic character of the rat's vision. Lashley (1) has reported that the far point is at about eight cm., which probably means that adaptation was constant for all distances tested in this study.

The other possible factors have been tested as follows

1. *Binocular Parallax*. Lashley has found that the binocular field of the rat is probably about five degrees in extent in the case of the relaxed position of the eyes. But each eye may rotate through about 25 degrees Hence, the possible binocular field is about 50 degrees There is incomplete decussation of the optic fibers He has noted some indication that the eyes of rats converge prior to jumping This latter observation is as yet unverified. Convergence, the turning of the eyes towards each other in order to bring the two images of an object upon the central part of the retinas, is lacking in animals without binocular vision These findings indicated that binocular factors might be important in depth recognition.

The left eye of *Y*3 was removed after the rat was put through the first series of jumps. Three days later, he was again put through a similar series of jumps No significant differences between the data of the two series could be detected. The animal from the first jumped accurately without hesitation. This militates against the importance of binocular factors. One eye was removed from each of two other rats, *A*3 and *B*3, and a similar series was run. Only the records of the latter two rats are available The correlation

TABLE 8

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR TWO MONOCULAR RATS

Force is expressed relative to the force exerted at 20 cm The force measures are the averages of 10 trials at each distance

Distance	Rat *A*3	Rat *B*3
20	100	100
25	260	178
30	242	248
35	323	279
40	330	284
45	310	292

between distance and force (expressed in percentage) is recorded in Table 8. For rat *B3* there is little difference between this series and that of Table 2 For *A3*, there are two inversions in the present series and one in the former series In the case of this rat, the force of the present series increased with distance to a much greater extent than in the first series. In view of the small group and because of the obscuring effect of practice, it is difficult to interpret the results. There is little reason here for assigning any influence to binocular factors. Other data will be presented later

2 *Monocular Parallax*. There is some evidence that monocular parallax may be a factor in identification of depth It was observed in the case of practically all rats that prior to the act of jumping their heads were moved from side to side The movement might allow of depth discrimination because monocular parallax, i e., the apparent displacement of near or far features of the visual environment with respect to far or near features It was thought that by employing screens as a background the resulting greater homogeneity in background would operate to decrease the efficacy of monocular factors, in case they were operative

The following experiment was conducted with rat *Y3*, with binocular vision, following the regular series of jumps A screen of dull black cloth (140 x 100 cm) was placed immediately behind the landing platform, extending vertically from the floor, 100 cm distant from the jumping ledge. Jumping was tested for the usual series of distances. There was no influence of the screen except that on the first day of the tests the first jump at 40 cm. (the third jump attempted) was short, and on day two the second jump at 40 cm was short also. It is doubtful that the screen operated to disrupt depth discrimination

What was thought to be a more effective screen was then employed with five rats with pigmented eyes and with two albinos The screen was made of heavy unbleached muslin and extended behind and on either side of the landing platform. It reached from the floor to a height of 140 cm. The width of each of the three sides was 100 cm. The rear screen was about 20 cm. behind the landing platform This served to eliminate all background except for the screen and landing apparatus. The foreground, below, remained as usual The regular series of jumps with 5-cm. steps was run, 10 trials at each distance, following the experiment on threshold The data are summarized in Table 9, each value being the

TABLE 9

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR SEVEN RATS, WITH THE U-SHAPED GRAY SCREEN

Also the total number of "short" jumps of each rat. The force measures are the averages of 10 trials at each distance

Distance	Rat Y2	Y3	Y4	B1	B2	A2	A3
20	178	142	183	153	162	194	146
25	316	241	263	224	255	276	327
30	362	329	295	301	278	297	443
35	415	360	320	392	340	326	474
40	458	406	330	465	399	332	507
45	491	413	343	516	396	347	599

total force at the distance specified (as in Table 1); the same data in percentages are contained in Table 10 (as in Table 2). Table 9 also contains the total number of short jumps made by each rat

Comparison of these tables with Tables 1 and 2 indicates that, in most cases, discrimination was probably a little better with the screen than without it. These facts are shown not only by the percentages of force and by the number of short jumps in the case of the albinos, but also by an analysis of the number of inversions in the original data. Practice may well account for the improvement It could be argued that practice might obscure a real difference between the screen situation and the non-screen situation as to discrimination of depth Because of small changes of calibration of the apparatus, the effect of practice could not be determined accurately Later, this factor will be evaluated

There are two other differences between the series with and the

TABLE 10

THE DATA OF TABLE 9 EXPRESSED IN TERMS OF PERCENTAGE

The force exerted at each distance is expressed in terms of the force exerted at 20 cm.

Distance	Rat Y2	Y3	Y4	B1	B2	A2	A3
20	100	100	100	100	100	100	100
25	178	171	144	147	158	142	222
30	203	233	161	197	173	153	302
35	233	252	175	255	210	168	325
40	258	288	180	302	247	171	349
45	275	292	188	338	246	178	410

series without screens. In the series with the screen, rats *A2* and *Y4* stood upon their hind legs and swung their heads to an unusual degree before jumping. The latter also frequently overjumped and alighted on the platform instead of upon the ledge. The other rats performed about as usual from the first.

Rat *Y3*, some time before serving in the screen series and subsequent to the first series, was tried also on a screen series which differed from the present screen series in that, immediately preceding the trials with the screen, the animal was required to jump 16 times at 35 cm without the screen. With the screen first at 35 cm. the rat jumped over the landing platform and struck the screen. This occurred for eight jumps. In turn, the right, left, and rear screens were removed and jumps were allowed after the removal of each screen The animal continued to overjump. The distance was decreased by small steps to 18 cm without any effect. At 14 cm *Y3* finally jumped. Several days' training similar to the training series described was instituted, with the result that the animal improved and jumped more accurately with respect to the landing ledge and did less overjumping. After three days, the work with this rat was discontinued for several weeks until the screen series with the group was started. As indicated, this rat formed a member of that group and jumped accurately from the first.

The facts above are difficult to interpret. The slight differences between the screen and the non-screen series might be due to a general difference of stimulation, to the substitution of the screen for the ledge as a jumping objective, or to what has been called practice It may also be due to a combination of these factors. The screens employed did not rule out thoroughly the possibility of the operation of monocular parallax.

Three animals were then put through the regular series of jumps but with a screen designed to eliminate monocular parallax more effectively. It was made of heavy unbleached muslin and it intercepted the background in line with the front edge of the landing ledge. It also curved down from the landing ledge towards the bottom of the pendulum stand, thus intercepting the foreground The only object other than the screen in front of the rat was the landing ledge. A flap in the screen permitted the rat, after jumping to the landing ledge, to go to the landing platform It is to be noted that such a screen would serve also to cut off rather effectively any olfactory cues that might be obtained from the landing

TABLE 11

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR THREE RATS, USING THE GRAY "SLOT" SCREEN

The force measures are the averages of 10 trials at each distance.

Distance	Force *B1*	Force *Y3*	Force *A2*	Percentage force *B1*	Percentage force *Y3*	Percentage force *A2*
20	184	207	205	100	100	100
25	299	316	208	162	152	101
30	432	425	252	235	202	123
35	536	468	253	291	226	123
40	581	424	273	315	202	133
45	655	435	287	356	210	140

platform The three animals used were *Y*3, *B*1, and *A*2. The records of force and percentage of force are in Table 11

There are two significant differences between this series and former series First, analysis of the original data shows that the number of inversions found between the random pairs of force values from each distance to the next greater distance is greatest in the case of the present series. The number of inversions which would result from perfectly random jumping would be 25 for any given animal in the case of 10 jumps at each of six distances. The table below indicates the number of inversions for each of the three rats in each of the three series Series 1 indicates the first series in which no screens were used. Series 2 indicates the previously described screen which extended around three sides of the apparatus. Series 3 designates the present screen series.

Rat	Series 1	Series 2	Series 3
*Y*3	6	8	13
*B*1	4	1	4
*A*2	12	10	15

It seems that discrimination suffered to some extent. Secondly, there was a much greater amount of overjumping in the case of the present series "Overjumping" is a term used to characterize jumps in which the animal obviously jumps over and beyond the landing ledge. It is difficult to interpret this result it may be due to the general changes in problem incident upon the introduction of the screen, or it may well indicate a breaking down in discrimination

3 *Size of Retinal Image.* The factor, size of retinal image, was next investigated with a group of three rats, *Y*2, *B*1, and *A*2. The

TABLE 12

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR THREE RATS UNDER THE CONDITION OF CONSTANCY OF APPARENT BREADTH OF THE LANDING LEDGE

The force measures are the averages of 10 trials at each distance

Distance	Rat *Y2*	*B1*	*A2*
25	290	275	232
30	349	339	260
35	383	400	275
40	445	440	293

side of the landing ledge facing the rat was altered in size by fastening to the ledge gray cards of uniform depth but varying in width according to the distance of the landing ledge from the jumping ledge. That is, 4 cards were used for each of 4 distances (25, 30, 35, and 40 cm.) so that the apparent breadth of the landing ledge would remain constant, with respect to the position of the rat, as determined geometrically, for the varying distances The distances were varied in chance order as usual and there were 10 trials for each distance Table 12 is a record of the correlation between distance and force. It is clear that there was no appreciable disruption of depth discrimination No rat made short jumps.

Rat *B*1, who jumped readily to the screen with the least amount of overjumping in the experiment with the last screen, was required afterwards to jump in a situation involving both the screen and constancy of the apparent size of the landing ledge Ten trials were run for each of 4 distances, varied in chance order Table 13 records the total force at each distance. Depth discrimination is still accurate but the increase in force as the distance increases from 25 to 40 cm. is less than it was in the former screen series for this animal.

TABLE 13

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR ONE RAT, UNDER THE CONDITIONS OF CONSTANCY OF APPARENT BREADTH OF THE LANDING LEDGE AND OF THE "SLOT" SCREEN

The force measures are the averages of 10 trials at each distance

Distance	*Rat* *B*1
25	262
30	304
35	342
40	379

TABLE 14

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR ONE RAT UNDER THREE CONDITIONS OF ILLUMINATION

Series 1, daylight illumination, Series 2, dim illumination, Series 3, very dim illumination. The force measures are the averages of 10 trials at each distance

Distance	Series 1	Series 2	Series 3
20	217	254	234
25	336	351	345
30	420	423	411
35	451	472	484
40	489	477	486
45	510	498	530

4 *Aerial perspective.* One rat, Y7, was employed in this experiment. The original series without screens was run under three conditions of illumination Series 1 was the usual daylight series Series 2 was carried out under dim illumination Series 3 was run under very dim illumination The results are recorded in Table 14 in terms of the total force for each distance in the case of each series. The curves representing the relation between force and distance are similar for the three series except that the curves ascend more uniformly as the degree of illumination increases Analysis of the original data shows that the total number of inversions for a given series decreases as the degree of illumination increases, the values being 10, 8, and 4 for the conditions dimmest, dim, least dim, respectively. This experiment controls some of the factors operative in aerial perspective It seems that the reaction was disturbed by the removal of certain cues subsummed under the head of aerial perspective It is possible that the disturbance may have been due to decrease in visual acuity, as such

Elimination of binocular vision, of monocular parallax, of the apparent size of the objects, and of cues operative under the heading of aerial perspective each produces some disturbance but does not abolish the identification of distance. It may be that the animal can use alternatively cues from these four different sources or that still other cues are important The remainder of the experiments are designed to eliminate the cues in combination to test between these alternatives.

The next set-up designed to break down discrimination consisted of an oval frame built completely around the jumping apparatus

Over the frame was draped black cloth of dull finish. The cloth extended from the floor to a height 18 inches above the jumping apparatus. The lateral distance between cloth and apparatus was everywhere about 12 inches. Black cloth was draped also from beneath the landing ledge back to the bottom of the jumping platform in order to secure a homogeneous foreground. In addition, the previously described arrangement to obscure the landing platform was used. A gray card was fastened beneath the landing ledge. The size of the card was varied in order to keep the size of the retinal image approximately constant. Thus, the surroundings of the animal placed upon the jumping platform consisted of homogeneous black cloth except that above the animal there was no cloth and in front there was the gray card above which the animal was to jump.

Preliminary jumps were allowed in order to accustom the animals to the situation. Two rats, *Y7* and *B5*, were employed in the usual series except that the distances were confined to the range 25-45 cm. Rat *B5* possessed one eye. Two series were run with *Y7*: the above "complete black set-up" and the original set-up involving no screens. Four series were run with *B5*: (1) the complete black set-up, (2) the same but minus the condition of constancy of apparent retinal size (i.e., the card designed for 25 cm. was used throughout), (3) the same as (2) but with the black cloth foreground removed, and (4) the original series.

TABLE 15

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR TWO RATS UNDER FOUR CONDITIONS OF BACKGROUND

Conditions 1 and 4 were employed with Rat *Y7*. All four conditions were employed with Rat *B5*. See text. The force measures are the averages of 10 trials at each distance.

Condition 1—the "complete black set-up"

Condition 2—the same as Condition 1 but minus the condition of constancy of apparent retinal size

Condition 3—the same as Condition 2 but with the black cloth foreground removed

Condition 4—the original series without screens

	Rat Y7		Rat B5			
Condition	1	4	1	2	3	4
Distance						
25	532	324	456	406	378	344
30	590	448	502	441	420	381
35	631	503	524	472	462	395
40	643	534	539	483	480	408

The results are recorded in Table 15. The conditions or series are numbered in the order presented immediately above. For both rats and all series there are no significant differences in discrimination as measured by differential force exerted. Analysis of the inversions contained in the original data furnishes no grounds for inferring differences in discrimination among the different series. But great differences are found among the series in respect to the amount of force used in general. Graphs representing the relation between total force expended and distance jumped show the following: For rat *Y7*, the graph for the complete black set-up is parallel to, but much higher than, the graph for the original series. The same is true for rat *B5*. The two additional series for the latter rat are parallel to the graphs of the other two series but are intermediate between them.

These results indicate that absolute force as well as differential force is worth taking into account. Although the rats discriminated the distances, as indicated by the criterion of differential force, they expended more energy in jumping under the more difficult conditions. This conclusion is strengthened by observation. As the series increased in difficulty, as designed by the experimenter, the animals hesitated more before jumping, and they overjumped more frequently.

The next experiment was designed to make the conditions of visual depth perception even more difficult. The jumping apparatus was placed in a dark room. Instead of the usual landing platform there was substituted a hollow box of the same length and breadth and 6.5 cm in depth. The top surface of the box was adjusted to the same height above the floor as that of the landing platform. The inside of the box was equipped with a 10-watt electric lamp supplied by city electricity. One inch from the open end of the box adjacent to the jumping platform a slot was cut through the side of the box to allow rectangular cardboards to be slid into the box, thereby closing the end. Five black-faced cardboards were made for this purpose, each containing, in the center, a rectangular area cut out and covered over by several thicknesses of thin, translucent oil paper. Each card bore a different size of rectangular area, each of which was carefully measured so that, for each of the five distances through which jumps were to be made, the areas would be such as to make the apparent size of the retinal images of the areas constant. The box was painted black inside and outside, the seams were covered with dull black cloth, and the front of the box was lined with the

same. With a card inserted in the box and the lamp within lighted, the only object visible in the room was the rectangular area of oiled paper through which the light of the lamp was transmitted. The experimenter and an assistant adjusted the thicknesses of oiled paper so that, for the various distances, there was no apparent difference in intensity of illumination of the oiled paper on the different cards. Behind the box was placed the food container.

One rat, *B6*, was used Many preliminary trials were given over the several distances to adjust the animal to the conditions, although he quickly adapted to the situation and jumped without much urging. However, more urging was required than in the case of any previous set-up. The usual series of jumps was then made. For each distance the appropriate card was slid into the box An assistant read the scale, using a flashlight screened to prevent light from penetrating into the room. Even so, a slight amount of light was diffused Following this series, one eye was removed from the rat, and one week later the series was repeated. Then the usual daylight series was run.

The results are contained in Table 16. They indicate that the animal discriminated in the daylight series very much better than in either of the other two series, and, of the latter, that he discriminated better under binocular conditions See Figure 3. In the binocular series discrimination failed beyond 35 cm ; in the monocular series discrimination failed at the same distance or possibly at 30 cm ; and in the daylight series there was no failure to discriminate Analysis of the number of inversions between the random pairs of force

TABLE 16

CORRELATION BETWEEN FORCE AND DISTANCE OF JUMPING FOR ONE RAT UNDER THREE CONDITIONS

See text The force measures are the averages of 10 trials at each distance
1 Binocular—the dark-room experiment with binocular vision
2 Monocular—the dark-room experiment with monocular vision.
3 Daylight monocular—the original daylight series with monocular vision

	Conditions		
	Dark room		Daylight
Distance	Binocular	Monocular	Monocular
25	437	484	214
30	577	551	301
35	630	562	442
40	636	541	528
45	630	562	579

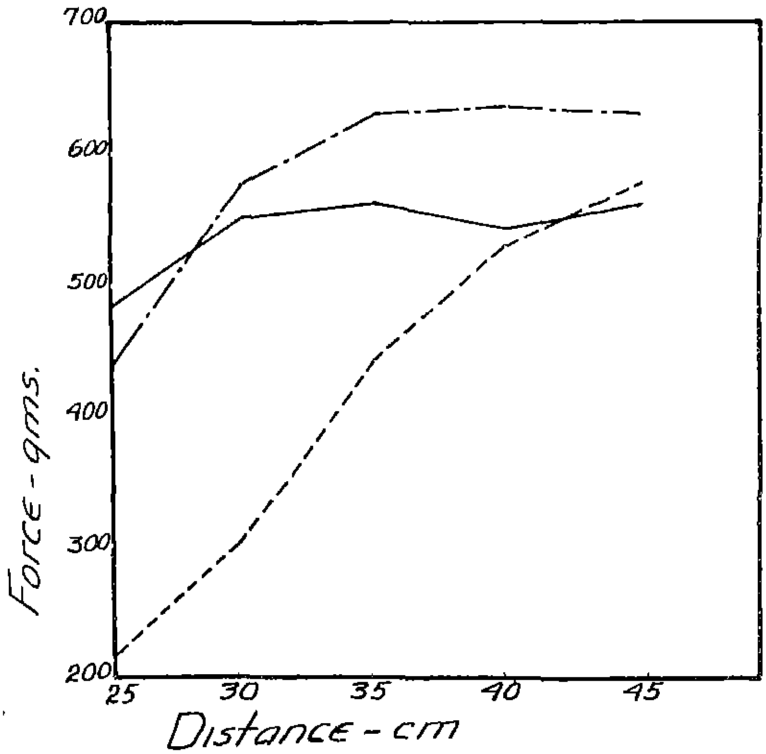

FIGURE 3

CORRELATION BETWEEN FORCE OF JUMPING AND DISTANCE TO BE JUMPED FOR ONE RAT UNDER THREE CONDITIONS

— — Dark room, size of retinal image constant, binocular vision
——— Dark room, size of retinal image constant, monocular vision
- - - - - Daylight conditions, monocular vision

values from each distance to the next greater distance shows that there were 2 inversions contained in the daylight series, 11 in the binocular series, and 17 in the monocular series. In the case of five distances, 20 inversions would be expected in case of perfectly random jumping.

The results show that both binocular cues and monocular cues operate in visual depth discrimination in the case of the rat. Experimental or operational removal of cues of either kind disrupts depth discrimination to a degree proportional, in general, to the number of cues removed.

CONCLUSIONS

A. Existence of visual depth discrimination in the rat has been demonstrated. The lines of evidence of such discrimination are as follows.

1. The force of jumping is correlated directly with the distance to be jumped, where the distances are varied in a chance order. The random order of distances excludes the possibility that the correlation is due to a "random force-training" sequence.

2. There is probably a difference in accuracy of depth discrimination between rats with pigmented eyes and rats with albino eyes, the rats with pigmented eyes being favored. This result accords with *a priori* judgment.

3. Change from heterogeneous to homogeneous visual background interferes with accuracy of jumping

4. There is a direct relation between distance required to be jumped and the degree of disinclination of the rat to jump. This result accords with the finding of Waugh in the case of mice

5 The force of jumping varies with the number of visual cues removed. The greater the number of visual cues removed the greater the force of jumping. Differential reactions to different distances may nevertheless be maintained.

B. Threshold of visual depth discrimination

On an average of 12 trials at each distance, for distances in the neighborhood of 20 to 40 cm., some rats with pigmented eyes always discriminate a difference of 2 cm The threshold seems to be lower for rats with pigmented eyes than for rats with albino eyes Under the conditions of the experiment, the albinos always discriminated a difference of 4 or 5 cm.

C. Mechanism of visual depth discrimination.

Suggestive evidence of binocular factors is found in possible movements of convergence of the eyes, in incomplete decussation of optic fibers, and in the possession of a binocular field

Suggestive evidence of monocular factors is found in swinging of the head prior to jumping.

Change from heterogeneous to homogeneous visual background by means of screens and dark-room control interferes with accuracy of jumping This suggests that monocular parallax may be a factor.

Removal of one eye interfered with depth discrimination This indicates that binocular factors sometimes may be important.

Interference with identification of depth produced by decreasing

the intensity of illumination of the surroundings may indicate that aerial perspective is a factor.

It is likely that both binocular and monocular cues operate in visual depth recognition in the case of the rat Experimental or operational removal of cues of either kind disrupts depth discrimination to a degree proportional, in general, to the number of cues removed

The investigations of the present paper are preliminary It is planned to continue with a more detailed study of visual factors and also of habituation.

References

1 Lashley, K S. The mechanism of vision I A method for rapid analysis of pattern-vision in the rat *J. Genet Psychol*, 1930, **37**, 453-460

2 ———, The mechanism of vision II The influence of cerebral lesions upon the threshold of discrimination for brightness in the rat *J Genet Psychol*, 1930, **37**, 461-479

3 ———, The mechanism of vision. III The comparative visual acuity of pigmented and albino rats *J Genet Psychol.*, 1930, **37**, 481-484

4 Richardson, F A study of sensory control in the rat *Psychol Monog*, 1909, **12**, No 48 Pp 124

5 Washburn, M F The animal mind New York Macmillan, 1917 Pp. xvii+386.

6. Waugh, K T The role of vision in the mental life of the mouse *J Comp Neur. & Psychol*, 1910, **20**, 549-599.

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LA DISCRIMINATION DE LA PROFONDEUR CHEZ LE RAT

(Résumé)

Le but de cette étude est de montrer de l'évidence de la discrimination visuelle de la profondeur chez le rat et d'analyser les mécanismes en jeu au moyen d'un appareil fait pour mesurer la force avec laquelle un rat saute d'une corniche à une autre corniche. On emploie la différence dans la force du saut comme critère de la différence dans la discrimination de la profondeur. On a varié au hasard les distances à sauter pour éliminer le facteur d'être accoutumé à une distance donnée. On a contrôlé les facteurs en jeu dans la discrimination visuelle de la profondeur au moyen d'écrans, d'une chambre obscure, etc.

Conclusions:

1. La force du saut est corrélée directement avec la distance qu'il faut que le rat saute.

2. Les rats aux yeux pigmentés discriminent mieux la profoundeur que les rats aux yeux albinos.

3. Il y a une relation directe entre la distance qu'il faut sauter et le degré et le manque d'inclination du rat à sauter.

4. Plus le nombre de suggestions visuelles enlevées est grand, plus la force du saut est grande.

5. Les rats peuvent discriminer facilement une différence de 2 cm. au cas des distances variant de 20 à 40 cm.

6. On trouve de l'évidence de facteurs binoculaires dans des mouvements possibles de convergence des yeux, dans un état incomplètement décussé des fibres optiques, dans la possession d'un champ binoculaire, et dans l'interférence avec la discrimination de la profondeur quand on enlève un oeil.

7. On trouve de l'évidence de facteurs monoculaires dans le balancement de la tête avant de sauter, et dans l'interférence avec l'exatitude du saut quand on change un fond visuel hétérogene en fond visuel homogene au moyen d'ecrans et de contrôle dans une chambre obscure. Cela indique que la parallaxe monoculaire peut être un facteur.

8. L'interférence avec la discrimination de la profondeur produite au moyen de décroître l'intensité de l'illumination des environs peut indiquer que la perspective aérienne est un facteur.

Il est probable que les suggestions binoculaires et monoculaires toutes les deux sont en jeu dans la discrimination visuelle de la profondeur chez le rat. L'enlèvement expérimental ou l'enlèvement pendant l'opération des suggestions de l'une et l'autre classe nuit à la discrimination de la profondeur à un degré en proportion en général du nombre des suggestions enlevees.

Russell

DIE FAHIGKEIT DER RATTE, ZWISCHEN VERSCHIEDENEN TIEFEN ZU UNTERSCHEIDEN

(Referat)

Es war das Ziel der Untersuchung, Beweis zu erteilen, dass Ratten zwischen verschiedenen Tiefen unterscheiden Konnen, und den in Einspruch genommenen Mekanismus zu analyzieren, mittels eines Apparates zur Messung der Kraft mit der eine Ratte von einem vorstehenden Rand zu einem anderen springt. Unterschiede in der Kraft des Springens werden als Kriterium der Unterschiede in der Tiefenunterscheidung gebraucht Die zu uberspringenden Distanzen wurden nach Wechselfall variirt um den Faktor der Angewohnung an einen gegebenen Abstand auszuschalten Die Bestandteile der visuellen Tiefenunterscheidung wurden durch Windschirme, Dunkelkammern, u.s.w , kontrolliert

Befunde

1 Die Sprungkraft steht in direkter Beziehung zu der Distanz, die die Ratte zu uberspringen hat

2 Ratten mit pigmentierten Augen unterscheiden Tiefen besser, als es Ratten mit Albinoaugen tun

3 Es besteht ein direkter Zusammenhang zwischen der zu uberspringenden Distanz und dem Grad der Abneigung der Ratte gegen das Springen.

4. *Je hoher die Zahl der visuellen Weisungen (cues) die man entfernt,* desto grosser die Kraft des Springes

5 Die Ratten bemerken leicht einen Unterschied von 2 cm bei Abstanden die zwischen 20 und 40 cm schwanken.

6 Beweise binokularer Einwirkungen werden gefunden in moglichen Konvergenzbewegungen der Augen, unvollkommenen Durchkreuzungen der Sehfasern (optic fibers), Besitz eines doppelten Gesichtsfeldes, und Storung der Tiefenunterscheidung nach Beseitigung eines Auges.

7 Beweise einaugiger Einwirkungen werden gefunden in dem Schwingen des Kopfes vor dem Springen, und in der Storung der Genauigkeit des Springens wenn man mit Windschirmen und Dunkelkammerkontrolle den heterogenen visuellen Hintergrund in einen homogenen veranderte Hierdurch wird angedeutet, dass die einaugige Parallaxe (monocular parallax) vielleicht eine Rolle spielt

8 Die durch Verminderung der Intensitat der Beleuchtung verursachte Storung der Tiefenunterscheidung weist vielleicht darauf hin, dass Luftperspektive (aerial perspective) vielleicht mit einwirkt

Es ist Wahrscheinlich, dass sowohl binokulare wie monoculare Weisungen bei der visuellen Tiefenunterscheidung in der Ratte wirksam sind Die experimentelle oder operative Beseitigung von Weisungen der einen oder der anderen Art stort die Tiefenunterscheidung zu einem Grade, die im Allgemeinen der Zahl der beseitigten Weisungen proportionell ist

RUSSELL

THE REACTIONS OF INFANTS TO CHANGES IN THE INTENSITY AND PITCH OF PURE TONE*[1]

From the Psychological Laboratory of Northwestern University

MARY WOODHULL HALLER

The purpose of this experiment was to study the reactions of infants to changes in the intensity and pitch of pure tone. Is a change in the physical nature of the stimulus, i.e., in the vibration rate and amplitude of the sound wave, associated with characteristic response from the human organism?

As far as the writer has been able to discover no systematic observation of the responses of infants to changes in the pitch and intensity in tone has been made. In practically all of the biographical studies and in some of the laboratory studies, however, statements are made as to the effect of sound on the infant. Miss Moore (17), in her very valuable study, *The Development of the Child,* says that it is difficult to judge the effect of relative intensities because it is hard to isolate in any complex experience the reaction to the auditory stimulus alone. She observed reactions on subsequent days to the voice, to whistling, singing, striking of the clock, etc. Rasmussen (19, Vol. 1) in his *Child Psychology* based on observation of his infant daughters, states that "a child of one month has been observed to show great joy over music, and that Tiedemann's son who had heard the piano played for the first time at the age of fourteen days was made thereby very lively and happy." D. R. Major (15) tested his child's reaction to auditory stimuli at the time it was twenty hours old by rapping violently on the bottom of a tin pan four feet from the child's head, and on subsequent days by striking two books together, by rapping sharply with a folded newspaper, by ringing a bell, blowing a whistle, shaking a rattle, and clapping the hands

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[1]Report of an experiment conducted in the Psychological Laboratory of Northwestern University. The work was done under the direction of Professor John J. B. Morgan.

Further tables and graphs are on file in the Graduate School of Northwestern University.

Dearborn (11) recorded responses from the sixth to the sixty-sixth day to the ticking of a watch, the blowing of a whistle, clapping of hands, playing a piano, rapping on a lamp shade, and the ringing of an alarm bell. He concludes from these observations that, in general, the infant heard high tones better than low and that notes in the upper register caused her to cry

No attempt in these or in similar studies was made to control the complex factors which determine the nature of the auditory response. The conclusions as to the effect of auditory stimuli are therefore based on an observation of responses to unlike causes The present research is an attempt to determine what the elements in the sensory experience are and, by control of these elements and a manipulation of one, to study the effect of such a change An analysis of these facts together with the method of controlling them and the interpretation of the results is the basis of the discussion that follows.

The experiment was carried on during the months of November and December, 1928, and of January and February, 1929, with the cooperation of The Cradle, an adoption nursery situated at 2049 Ridge Avenue, Evanston, Illinois Through the courtesy of Mrs. Walrath of this institution we were allowed to observe the infants then being cared for

The age of the infants used was in part determined by the nature of the institution which is not a maternity hospital. The majority of the babies brought in at the end of the mother's period of confinement are from ten to fourteen days old Since some of these children are necessarily under close medical supervision for the first few days and are frequently adopted in a few weeks, it was found most practical to use infants not less than three weeks or more than five weeks old. This proved a most satisfactory age level, as, by preliminary experiment, infants younger than three weeks were found to be very insensitive to all stimuli, and older infants already too highly conditioned to the usual occurrences in the environment to make it possible to eliminate the error of uncontrolled sounds elsewhere in the building.

Nineteen white infants, all of this age that were available during these months, were observed, some of them once and some several times Eleven of them were boys and eight were girls. No comparison was made of sex differences, and no information could be secured as to their nationality The selection was determined, then, solely on the basis of age and physical condition One sickly baby

and one boy of three months were tested, but merely for purposes of comparison, and their responses were not included in the normal totals

A pure tone of a uniform quality was produced by a two-B Western Electric Audiometer which was connected through a 34-A Western Electric Amplifier with a Western Electric Loud Speaker, the cone of which was 25 inches in diameter.

The pitch of the tone was controlled by throwing in the keys at the upper right-hand corner of the instrument. Eight tones could be produced at intervals of an octave, beginning with 64 v and ending with 8192 v. The intensity of the tone was controlled by means of a revolving disc which was accurately calibrated in terms of sensation units. The smallest steps of increase were five sensation units This disc turned within an outer circle upon which were indicated the eight pitches Either a sudden or gradual tone could be secured by operating successively first the disc or the keys

Four intensities were used, the lowest was a medium, even tone neither very soft nor yet loud enough to be at all unpleasant This tone was increased three times by regular intervals, indicated by the calibration of the disc, to the fourth or maximum intensity. Only seven pitches were used, as 8192 v had to be eliminated At high intensity this rapid vibration rate caused a snapping and crackling which gave room for too much error. There is some doubt, also, as to whether 4096 came through with as relatively great an intensity as the lower pitches. It, too, was sometimes accompanied by a crackling of the loud speaker, and it is quite possible that the instrument was not flexible enough to reproduce perfectly the amplitudes of the intense high pitches. Certain other experimental difficulties in the control of the intensity and pitch should be mentioned here.[2]

1 The tonal quality was not always uniform On some days there was a noticeable beat at the high intensity of the low pitches, and in the higher pitches harmonics could often be detected

2 When changing from one intensity to another, the gradation was not by sufficiently small steps to be sure that the factor of suddenness was perfectly eliminated and there were often disagreeable starting and stopping noises when a change was made to or from the high intensities. These difficulties were never perfectly overcome and were a fairly constant factor all through the experiment

[2]A P. Weiss (30) discusses the requirements for control of auditory stimuli in sound experiment

Suddenness has been mentioned above as an experimental error. Except during the preliminary observations a sudden tone was not used. A rapid change in any environmental condition seems to be disturbing to infants whether it be associated with sensations of sound, light, temperature, pressure, or bodily support. It was observed that sudden cessation of a sound was as disturbing as sudden occurrence of sound and that a light turned off or on suddenly in a dark room caused the infant to start and cry This seems to be purely a reflex response resulting from a necessarily quick physiological adjustment. Therefore, when a sudden tone is produced or changed in intensity and pitch, it is impossible to tell to what extent the child's reaction is a response to the change in vibration rate and amplitude and to what extent it is due to the factor of sudden environmental change. So, to isolate the factor of pitch and intensity it was thought necessary to eliminate the irrelevant and confusing factor of suddenness

The decision as to how long the stimulus should continue was based on two considerations

1 We wished to observe primarily the initial reaction and not the adjustmental behavior in response to the stimulus, that is, we wished to eliminate learning so far as possible It was never possible to do this entirely, as even with stimulations of short duration some infants rapidly adjusted to the sound situation and, though they gave evidences of awareness of the stimulus, their responses became less pronounced [3]

2 We wished to eliminate the factor of fatigue.[4] In order to observe the effect of a variation in the stimulus it is necessary to have an organism which is constantly at its highest point of sensitivity. The duration of the tone was therefore fixed at ten seconds, which was thought to be sufficient time for the stimulus to be adequately

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[3]Some infants adjusted much more rapidly than others Interesting speculations might be made as to the relative intelligence of the children showing these individual differences

[4]Frank A. Pattie (26) finds that there is a diminution of response to auditory stimulations as a result of fatigue and that these effects are more pronounced and prolonged at the high intensities and pitches He uses a 2A Western Electric Audiometer in his experiment and states that the duration of fatigue effect is about thirty seconds when the duration of the tone is one minute *The degree of fatigue is less with a weak than with a strong tone* The amount of fatigue produced by a stimulus of two minutes is usually more than that produced by a stimulus of one minute and a stimulus of one minute produces more fatigue than a stimulus of 20 or 30 seconds

perceived In order to further eliminate adaptability and fatigue a period of rest was allowed between the production of the sounds. This was fixed at from one to two minutes, but when very disturbed reactions were exhibited or following very high intensities this rest period was extended and the duration of the stimulus was in these cases sometimes slightly shortened.

The order in which the intensities and pitches were produced was also determined by the wish to control adaptability and fatigue and, in addition, to eliminate in the response the effect of the just preceding stimulus or intensity Three stimulations were given at each of the seven pitches and for each of the four intensities, but the order of the intensities and pitches was varied with each trial so that the same pitches and the same intensities did not follow each other.

The spatial relation of the vibrating mechanism to the subject was controlled by keeping the loud speaker at a constant distance (5 1/2 feet) from the crib. The loud speaker was turned at a given angle and always placed in the same location. The observer stood back of the crib in such a position that she could operate the audiometer and observe the child without being in its line of vision. It was impossible, however, to control the infant so that the ears were uniformly stimulated and this is a serious source of error. A turning of the head to one side may so alter the relative auditory impression that the sensory experience is radically changed. This was most obvious to the observer who was able, even when maintaining the same position, to reduce the painful sensations of the great intensities by turning the head so that its acoustical shadow greatly reduced the tonal impression. In addition to this resulting inconstant condition of the binaural ratio, a turning of the head also altered the phase relations of the tone.

A tone of a specific timbre, rate, and amplitude produced in a room of certain dimensions and contents will result in a different sensory impression than an identical tone produced in a different room. This is due in part to the variation in the reflection of the vibrating waves from different surfaces and spaces Atmospheric conditions, such as temperature, humidity and air pressure, may also vary the tonal quality. It was necessary, therefore, as well as convenient, to do the experiment in one room. A small room containing the same articles of furniture and separated from the nursery by a long hall served as a laboratory No attempt was made to

control atmospheric conditions except to keep the doors closed and to regulate the temperature by small ventilators in the windows rather than by raising them. This served also to eliminate as far as possible the error of sounds produced outside the laboratory. The production of sounds within the laboratory was controlled as rigidly as possible Great care was taken that the movements of the observer should be reduced to the greatest possible minimum.

If the human response to sound waves were purely tropistic our difficulties would be largely solved by a control of the external stimuli. But this is not the case. The sensory experience and the organic response depends not solely, nor perhaps mainly, on the stimulus but also upon the condition of the receptive organism, be it amœba or man The deaf mute is neither pleased nor disturbed by sound, and two subjects having normal and equal auditory acuity may be so influenced by other physiological conditions that with an *identical stimulus the response of one may be augmented and the* response of the other inhibited.[5]

But as far as possible the physical condition of the subject was kept constant, as has been said, children of nearly uniform age were used and only those that were thriving and free from temporary physical disability. In addition to this, they were observed at a regular time in the day This was directly after the feeding at 10 00 A.M or the one at 2 00 P M The child was at this time usually comfortable and relaxed. An examination of the records shows that some of the trials were made on crying children, some on sleeping, and some on quiet, awake children The findings in each case were, however, kept separate, totaled in kind, and used for purposes of comparison.

Every attempt was made to see that the infants were uniformly comfortable. The clothing and bedding was always identical and that to which the infant was accustomed The window shades were drawn so that the light was not trying, and at no time was an artificial light used during the experiment

[5]No tests for auditory acuity were made, and no comparisons were made between the infants' responses to this unfamiliar auditory stimulus and their responses to auditory stimuli to which they were already conditioned However, during the preliminary observation it was noticed that one infant of four weeks responded instantly near his feeding time to the light sound of the nurse's footsteps as she came down the hall toward the room although he showed no awareness to sounds of great intensity of the audiometer

The only method used to measure the effect of the stimulus on the infant was to observe and describe the somatic behavior which occurred with or directly following it. There are certain obvious criticisms of this procedure.

1. Auditory sensations are not received alone but are associated with many other sensations received concomitantly. We cannot be sure, therefore, that what we observe as the apparent effect of the auditory stimulus is the result of it alone or, indeed, that the response has more than chance connection with the stimulus.

2. The personal observation and description of the effect of the stimulus is too variable and subjective a measure to be reliable. The observer may wrongly describe the reaction, reading into the behavior what he expects or wishes to see, or he may misinterpret it for other reasons.

3. The inference that certain reflex acts are indicative of discomfort or comfort may be wrong.

In answer to these criticisms it may be said:

1. If we find under controlled conditions that in response to a given stimulus a similar reaction tends to recur with very great frequency we may be fairly certain that there is more than chance relation between them.

2. It is possible with adults to get a more accurate and objective measure of their emotional reactions by the use of instruments. But the extreme sanitary precautions taken with infants in institutions makes it impossible to handle them promiscuously, and it is furthermore very probable that the use of measuring apparatus would in itself be so disturbing a factor that it would introduce more error than resulted from a personal misinterpretation of the behavior. In order to avoid being unduly influenced by the results of individual experiments, no records were totaled or comparisons made until the period of experimentation was over.

3. As to the last criticism, only those reflex acts which were objective expressions of feeling were recorded as disturbing or soothing. It has been for so long observed that certain somatic behavior is associated both in man and animal with comfort and discomfort that we feel justified in interpreting the more obvious responses as an expression of those states in infants.[6]

But let it be here clearly understood that absolutely no assump-

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[6]See Crile (5, Chaps 7 and 8) and Darwin (6)

tion was made as to the emotional meaning of these reactions to the child. The emotions such as fear, anger, and love we take to be complex integrations of the immediate organic response to the stimulus plus remembered past experiences. They involve not only the present experience but also the memory of a past effect. We are accustomed to reason through analogy that because flushing, starting, or crying is an accompaniment of the emotional state of fear or anger in the adult, it is an indication of a similar emotional state in the infant.[7] This is a dangerous procedure and without doubt often wrongly ascribes to the newborn complex emotional experiences which can only be had as a result of conditioning.

All observers of young *infants seem to agree that at birth and* during the early months the pain-expressing apparatus is more highly developed than the pleasure King (14, p. 59) says that the child *has at birth a small number of motor coordinations and in these the* tensions resulting from an unwonted or strong stimulus are apt to find easiest relief. Miss Moore (17, pp 37-42) finds that during the early weeks of life the facial expression varies greatly as a result of spontaneous movements of the muscles of the face. The method of expressing displeasure, discomfort, and pain seems to be perfected at birth, but the method of expressing pleasure appears later and undergoes many transformations only becoming clearly defined with the dawning of intelligence. D. R Major (15, pp. 72-117) states that the infant at birth shows active signs of discomfort but that expressions of comfort and well-being are mild and unnoticeable "since it is more important for biological reasons to express unpleasant than pleasant states."

This was also true of the infants studied in this experiment. There were many varieties of behavior which were interpreted as positive signs of discomfort, but the response which indicated pleasure consisted almost entirely in a mere cessation of motor activity. Crying, if present, diminished or stopped, there was less motion of the arms

[7]*The statement that infants "fear loud sounds"* is *frequently* made by psychologists and almost invariably occurs in articles by laymen Dr W A Evans in *Chicago Daily Tribune,* March 31, 1929, discusses the relation of the infants' fear of sounds to their health and states that the fear re*actions induced by sounds cause harmful physiological changes particularly* of the autonomic processes These are evidenced by an increase in muscle tension, change in blood pressure, diminution of the flow of digestive juices, secretion of the suprarenal glands, etc In this and similar articles the assumption is that the infant is "afraid of the auditory stimulus" and that the emotion of fear brings about the autonomic responses described

and legs, the muscles of the face became relaxed, there was no tendency to flush, the respiration became even and slow, the eyelids trembled and drooped, and sleep sometimes followed. Three babies smiled. This seemed to be a purely reflex act occurring with two individuals at tones of high pitch and intensity. The same type of fleeting smile may be elicited when an infant's face is gently touched or stroked with a finger and may have been similarly caused here by the impact of the vibrating air waves on the face. It was perhaps inaccurate to describe it as an indication of pleasure However, since it was not accompanied or followed by any signs of discomfort it was so recorded three times. One other positive expression of pleasure which occurred markedly in two cases was what might be called the listening attitude This was most pronounced in the case of a four-weeks-old girl. She was a very well-nourished and healthy baby, said to be the child of musical parents. Whether because of greater sensitivity to sound, greater alertness, or for some other cause, she seemed to be much more aware of the auditory stimuli than were any of the other infants observed. During all of the medium intensities of all pitches she opened her eyes very wide and turned her head toward the source of the sound There was a lightening and relaxation of the facial muscles which goes with what we think of as a pleased expression During this all motor activity ceased. This pronounced listening attitude and expression of pleasure occurred once more in the case of a four-weeks-old boy during tones of sixty-four vibrations This infant seemed also to be very alert and sensitive to all external stimuli He smiled when spoken to, followed with his eye the moving finger, and turned his head toward the source of sound This response occurred occasionally in other records but never so positively or continuously as in these two. It may be that these infants were showing a later development of the pleasure expression because of greater mental maturity.

If the stimulus, as far as could be told, failed to affect the child, that is, if it caused no evident change in its activity or expression, the response was considered negative Without doubt many of these stimuli may have been soothing or disturbing and may have occasioned positive physiological changes in the infant which influenced the character of its reactions to later stimuli. But, without the evidences of overt behavior, there was no justification for interpreting them otherwise

As has been said above, there were many ways in which discomfort

was expressed The least of these was perhaps the slight start involving a flexion or extension of one or more of the limbs. If the stimulus was more disturbing, this activity became more general, involving all of the muscular coordinations then achieved. The child which had been lain on its back at the beginning rapidly and violently extended and flexed its limbs and also moved the arms at the shoulder, waving them rapidly and aimlessly about These infants were still too young to turn or raise the trunk and there were no motions of the head except for an occasional turning of it from side to side In addition to these random movements, there was a tendency to cry. This varied from a trembling or a curling of the lower lip and a drawing down of the corners of the mouth to slight momentary or violent and continued crying With this last response the respiration was always increased However, increased respiration, flushing, knitting of the brows, and other accompaniments of crying often occurred alone and were always interpreted as signs of discomfort Four sleeping infants showed a peculiar squirming or writhing response, involving, rather than lustly kicking, a sort of circular motion of the shoulders and a sideways movement of the trunk at the waist Two other sleeping infants, when stimulated with high intensities at 2048 v, shuddered as one does at cold, and with one of these the shuddering was invariably accompanied by a chattering of the jaw. This was the only child who thus responded. It sometimes happened that there was an expression of pain without any other signs of disturbance There were horizontal wrinkles in the brow and the inner corners of the eyebrows were raised.[8] The mouth was drawn down and the face looked old and tense. One child also blinked its eyelids while contracting the facial muscles as though a blow were being directed toward it or a bright light were shining in its eyes. There was very frequently a great increase in the reflex sucking motions as the disturbance increased and an attempt to get the hand to the mouth.[9]

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[8] F H Allport perfectly describes this expression in his *Social Psychology* (4, p 204).

[9] Infants of this age are still usually unable to inhibit the random motions of the arms and though obviously satisfied when the thumb by chance enters the mouth cannot keep it there when excited by intense stimuli It is an interesting example of a yet imperfect attempt to inhibit one response in favor of a desired one They varied considerably in this ability to inhibit reactions, some responding mechanically and invariably to each auditory stimulus, others even at the second occasion of the sound checking or stopping their reaction

All the behavior which has here been described as a response to auditory stimuli was no different in kind than the behavior which occurred in response to other stimuli. The child showed just the same type of disturbed responses when its bed covering was too tightly tucked in, or when it was hungry or in pain, and it quieted or went to sleep in exactly the same way when it was patted or fed. The degree of the response also seemed to be definitely related to the intensity of the auditory stimulus and it very rarely persisted after the cessation of the tone.

Results

The nature of each response at each intensity and pitch was recorded as follows

+indicated slight discomfort
d indicated definite discomfort.
– indicated no response.
s indicated comfort.

These responses were recorded on individual record charts which indicated also:

1 The name and age of the infant
2. Time of day.
3. Condition of the infant (crying, sleeping, awake).
4 Duration of the stimulus.

Summary of Data

	Records
Duration 10"	
Sleeping infants	11
Quiet, awake	10
Crying	8
Total	29
Duration 2'	
Sleeping infants	3
Crying	1
Whole nursery	1
Total	5
No. of infants tested	
Boys	11
Girls	8
Total	19
Records totaled and graphed	
Sleeping infants	10
Crying	6
Quiet awake	8
Total	24

Responses observed	
In 24 normal records	2520
In 10 records not included	749
Total	*3269*

TABLE 1

	Stimuli	%–	%d	%s	Total %
Asleep	1148	71 9	26 6	1 5	100
Crying	616	54 7	19 5	25 8	100
Awake	784	52 6	27 8	19.6	100

Effect of Physiological Conditions on Reactions Table 1 indicates that the nature of the response varies with the physiological condition of the subject. Of 1148 stimulations that were given to sleeping children, 71.9% of the responses were negative. Of the 616 stimulations given to crying children, 54 7% were negative. Of the 784 stimulations given to children who were quiet and awake, 52 6% were negative This means that stimulations of like intensity and pitch are not always equally perceived

A comparison of the disturbed responses in the three conditions indicates that there will be less evidence of disturbance while the child is crying than while he is asleep or quiet and awake. This is due in part to a probable misinterpretation of the behavior following the stimulus, for it is very difficult, first, to tell when a child is crying whether his continued crying is due to the auditory stimulus or to an earlier stimulus which occasioned the original disturbance, and, secondly, to judge whether or not the crying is augmented

In contrast, when the child is crying the effect of quieting stimuli is very evident The cessation of motion and crying is a more obvious quieted reaction than the mere absence of disturbance which may result from a pleasing stimulus when the child is asleep or quiet The crying child also tends to be quieted by very intense stimuli which would ordinarily be disturbing, and this, in its turn, increases the number of *s*-responses [10]

[10] A sickly baby who was in considerable bodily discomfort and cried constantly from pain was tested to compare her reactions to the normal sample She paid very little attention to the low intensity but was instantly quieted by the high intensities and pitches and went to sleep during them, crying as soon as they ceased The auditory stimulus which would have been disturbing to a normal baby was soothing in contrast to the pain stimulus over which it was temporarily prepotent Preyer caused the auditory reflexes in newborn guinea pigs to be inhibited by pinching the ears sharply

Likewise, the sleeping child who is at the highest point of the soothed reaction shows no variation in his behavior when a soothing stimulus is given The 1.5% of *s*-reactions that are recorded in the sleeping column occurred when the child was sleeping restlessly and quieted at the occasion of the stimulus.

A consideration of all the factors that affect the individual's degree of sensitivity to a stimulus is not within the scope of so brief a study, but it should be constantly borne in mind that the result produced and recorded must be interpreted in relation to the condition of the infant's responding.

d-responses. There is a steady increase in the percentage of the disturbed reactions with an increase in the intensity of the stimulus. At a maximum intensity the *d*-responses are seven times as frequent as at the lowest intensity. When the child is crying the *d*-responses are six times as frequent at the highest as at the lowest intensity

s-responses. There are practically no *s*-responses when the child is sleeping. The greatest number of *s*-responses occur when the child is crying, and they remain practically constant with a very slight increase for the high intensities. The second intensity is the most pleasing when the child is awake and quiet. The *s*-reactions diminish as the intensity increases but are practically the same in frequency at the highest as at the lowest intensity.

Ratio between s- and d-reactions. At the low intensities when the child is crying the *s*-responses are five times as frequent as the *d*-responses. This ratio between the *s*- and *d*-responses changes as the intensity increases so that at the greatest intensity the *s*-responses

TABLE 2 (Figure 1)

SHOWING THE EFFECT OF THE CHANGE IN INTENSITY IN A TONE OF 10" DURATION, PITCH CONSTANT

Like reactions to all stimuli of a given intensity are combined without regard to pitch. The numerical totals in each case are changed to percentiles

	a Asleep—10 cases 287 stimuli at each intensity			*b* Crying—6 cases 154 stimuli at each intensity			*c* Awake—8 cases 196 stimuli at each intensity		
Intensity	%—	*d*	*s*	%—	*d*	*s*	%—	*d*	*s*
Medium	91 6	7.1	1 3	69.5	5 2	25 3	80 1	5 1	14 8
− 10%	75.2	21 7	3 1	50 4	18 2	21.4	63 3	10 2	26 5
+ 10%	64 2	35.1	.7	48 0	24.0	28.0	48 0	31.6	20.4
Maximum	56 8	42 5	7	40 9	30.5	28 6	18 9	64.3	16 8

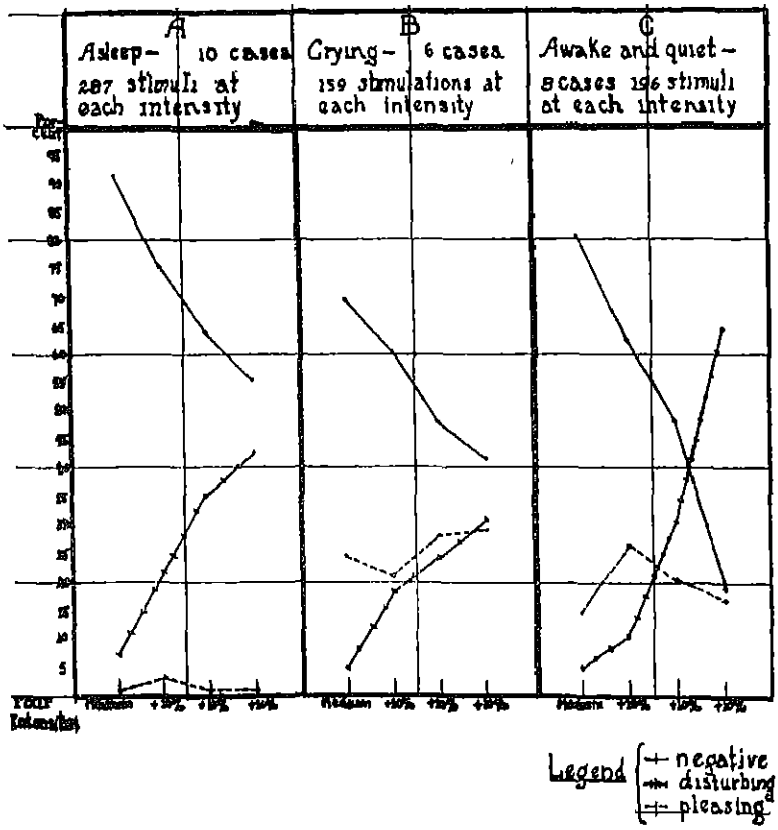

FIGURE 1
EFFECT OF CHANGE IN INTENSITY OF PURE TONE OF TEN SECONDS' DURATION (PITCH CONSTANT)

which have remained constant are slightly less frequent than the increasing *d*-responses. At the second intensity when the child was awake and quiet the *s*-response was twice as frequent as the *d*-response. After this the number of *s*-responses declined as the *d*-responses increased so that at the maximum intensity the *d*-responses were four times as frequent as the *s*-responses.

Figure 1 is a graphic representation of Table 2.

d-reactions In *a*, *b*, and *c* the smallest number of disturbed reactions occurs at 64 v The number of disturbed reactions increases

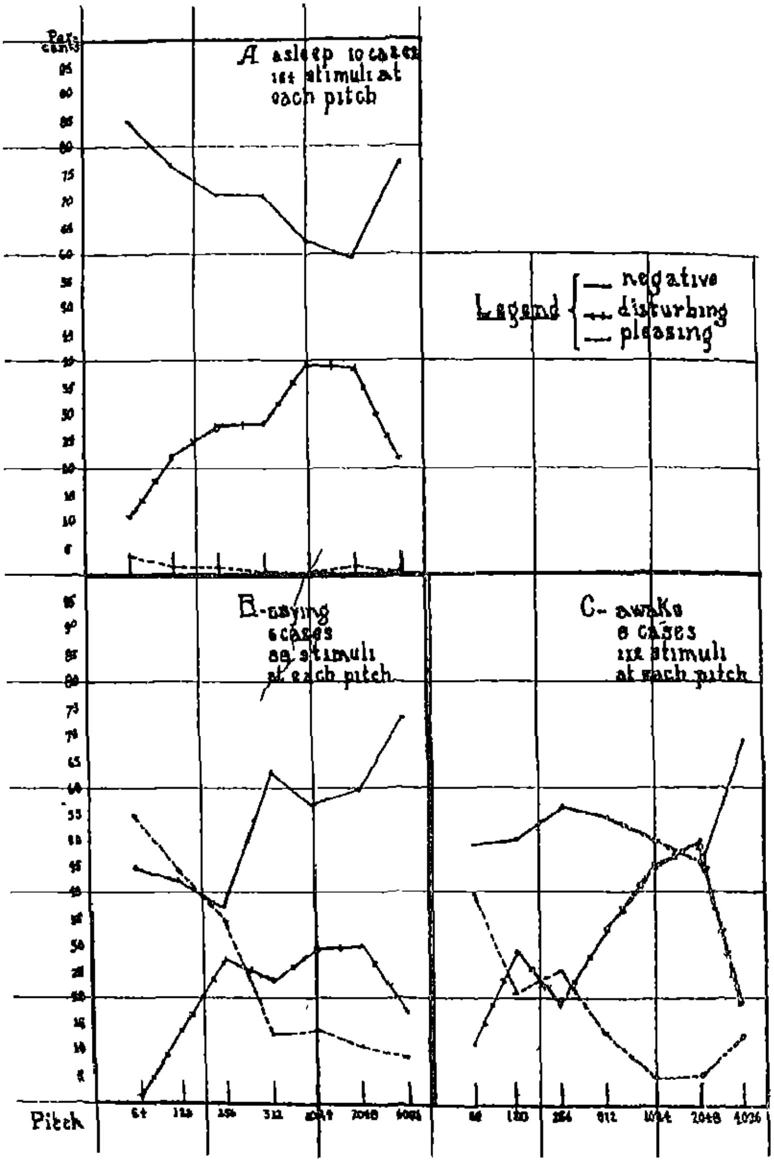

FIGURE 2

EFFECT OF CHANGE IN PITCH, TEN SECONDS' DURATION
(INTENSITY CONSTANT)

TABLE 3 (Figure 2)

SHOWING THE EFFECT OF THE CHANGE IN PITCH IN A TONE OF 10" DURATION, INTENSITY CONSTANT

Like reactions to all stimuli of a given pitch are combined without regard to intensity. The numerical totals in each case are changed to percentiles

	a Asleep—10 cases 164 stimuli at each pitch			*b* Crying—6 cases 88 stimuli at each pitch			*c* Awake—8 cases 125 stimuli at each pitch		
Pitch	%—	*d*	*s*	%—	*d*	*s*	%—	*d*	*s*
64 v.	85 4	10 9	3 7	44 3	1 1	54 6	49 1	11 6	39 3
128 v	76.2	22 0	1 8	42 1	13 6	44 3	50 0	29 5	20.5
256 v.	71 3	27 5	1 2	37.5	27.3	35 2	56 3	18.7	25 0
512 v.	71 3	28 1	.6	63 6	23 9	12 5	54 5	33 0	12 5
1024 v	62 2	38 8	0 0	56 8	29.5	13 7	50 0	44 6	5 4
2048 v	59 8	38 4	1 8	59 1	29 5	11 4	45.5	48 2	6 3
4096 v	76 8	22 0	1.2	73 9	17 0	9 1	68.8	18 7	12 5

as the vibration rate increases up to 1024 v. In *a* and *b* it remains constant till 2048 v In *c* the percentage of *d*-reactions increases again at 2048. In all three records there is a sudden decline in the percentage of disturbed responses at 4096 v., and in each record there is a corresponding increase in the percentage of negative responses at this pitch

s-reactions. In *a*, *b*, and *c* the greatest number of *s*-reactions occurs at 64 v. and declines in frequency as the vibration rate increases. In *c* there is a very slight rise in the percentage of *s*-reactions at 4096 v

Ratio between s and d. While there are three times as many *d*- as *s*-reactions at 64 v , at 2048 there are 38 times as many *d*- as *s*-reactions (*s*- negligible in this record) There are 54 times as many *s*- as there are *d*-reactions at 64 v, but at 512 v the *d*-reactions become almost twice as frequent as the *s*-reactions, and at 2048 the *d*-reactions are approximately 2½ times as great as the *s*-reactions While at a tone of 64 v. the *s*-reactions are over three times as frequent as the *d*-reactions at 2048, the point of highest disturbance, the *d*-reactions are eight times as frequent as the *s*-reactions In all these records, in spite of the decline in disturbing reactions at 4096, this pitch is more disturbing than a tone of 64 v

Figure 2 is a graphic representation of the above.

CONCLUSIONS

1 Pure tones of great intensity are more disturbing to infants than are pure tones of low intensity.

2 Pure tones of a high vibration rate are more disturbing to infants than are pure tones of a low vibration rate.

a. When the duration of the tone is lengthened it is more difficult for infants to adjust to pure tones of high intensity and a high vibration rate than it is for them to adjust to pure tones of high intensity and a low vibration rate.

3. Young infants show more positive and varied expressions of discomfort than of comfort in response to auditory stimuli.

4. The effect of an auditory stimulus on an infant depends upon its physiological condition, and upon all other concomitant internal and external stimuli.

5 The reactions of young infants to auditory stimuli are reflex, undifferentiated responses which are definitely related to the intensity of the stimulus, and do not usually persist after the removal of the stimulus.

a There is no reason to suppose that these reactions are caused by the emotion of fear.

References

On Conditioning

1 BAGBY, E Psychology of personality; an analysis of common emotional disorders. New York. Holt, 1928. Pp 244 (Chap 3)

2 PAVLOV, I. P Conditioned reflexes. London Oxford Univ. Press, 1927 Pp xv+430.

3 WATSON, J. B, & WATSON, R R. Conditioned emotional reactions *J. Exper Psychol.*, 1928, 3, 10-14.

Expression of Feeling

4. ALLPORT, F H Social psychology. Boston. Houghton Mifflin, 1928 Pp. xiv+453. (Chap 9)

5. CRILE, G W Origin and nature of the emotions Philadelphia: Saunders, 1915 Pp vii+240. (Chaps 6, 7, 8.)

6. DARWIN, C. R The expression of the emotions in man and animals New York. Appleton, 1905.

7. WATSON, J B, & MORGAN, J. J B. Emotional reactions and psychological experimentation *Amer J Psychol.*, 1917, 28, 163-174.

Development of the Child

8. ALLPORT, F. H Social psychology Boston Houghton Mifflin, 1928 Pp. xiv+453. (Chaps 1-4)

9 BLANTON, M G Behavior of the human infant during the first thirty days of life *Psychol. Rev.*, 1917, 24, 456-483.

10. DARWIN, C. A biographical sketch of an infant *Mind*, 1877, 2, 285-294

11. DEARBORN, G V N Moto-sensory development: observations of the first three years of a child Baltimore, Md Warwick & York, 1910. Pp. 215.

12 GESELL, A Mental growth of the pre-school child. New York Macmillan, 1925 Pp. 447

13 JONES, M. C. Development of early behavior patterns in young children. *Ped. Sem*, 1926, **33**, 537-585

14 KING, I Psychology of child development Chicago Univ Chicago Press, 1903 Pp viii+394.

15 MAJOR, D. R First steps in mental growth, a series of studies in the psychology of infancy. New York Macmillan, 1915 Pp xiv+360

16 MATEER, F Child behavior Boston Badger, 1918 Pp 239

17 MOORE, K C The mental development of a child *Psychol. Rev.*, 1896, **1**, 1-137.

18 PETERSON, F., & RAINEY, L H Beginning of mind in the newborn *Bull Lying-in Hosp City of New York*, 1910, **7**, No 3, 91-122

19 RASMUSSEN, V Child psychology New York. Knopf, 1923 (Vol 1, Chaps 1-4). Pp xi+130

20. SHERMAN, M Inventory of sensory reactions *Arch. Neur. & Psychol.*, 1924, **12**, 245-247

21 SHINN, M. W The biography of a baby Boston Houghton Mifflin, 1900 Pp 247

22 TIEDEMANN, D Consideration of the development of psychic qualities in children, 1787 Trans. by C. Murchison and S Langer, *Ped Sem.*, 1927, **34**, 205-230

23 WATSON, J B, & WATSON, R R Studies in infant psychology *Scient Mo*, 1921, **13**, 493-515

24 ————. Psychological care of infant and child. London Allen & Unwin, 1928 Pp. 160 New York Norton, 1928. Pp 195

On Sound

25 HARVEY, E N., & LOOMIS, A. L High frequency sound waves of small intensity and their biological effects *Nature*, 1928, **71**, 622-624.

26 PATTIE, F A Auditoiy fatigue. *Amer J Psychol.*, 1927, **38**, 39-58.

27 RICHARDS, W. T, & LOOMIS, A. L Chemical effects of high frequency sound waves *J. Amer Chem Soc*, 1927, **49**, 3086-

28 SCHMIDT, F O, OLSON, A R, & JOHNSON, C H Effects of high frequency sound waves on protoplasm *Proc Soc Exper Biol. & Med.*, 1927-1928, **25**, 718-720

29 WEISS, A P Apparatus and experiments on sound intensity *Psychol Monog*, 1916, **22**, No 95 Pp 59

30 ———— Preliminary report on the relative intensity of successive, simultaneous, ascending and descending tones. *Psychol Rev.*, 1917, **24**, 154-156

31 WOOD, R W, & LOOMIS, A. L The physical and biological effects of high frequency sound waves of great intensity *Phil Mag*, 1927, **4**, 417-436

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LES RÉACTIONS DES ENFANTS AUX CHANGEMENTS DANS L'INTENSITÉ ET LA HAUTEUR DU TON PUR

(Résumé)

On a faite cette expérience dans le but d'étudier systématiquement et dans des conditions contrôlées les premières réactions des enfants aux changements dans l'intensité et la hauteur du ton pur. On a observé 19 enfants de race blanche en bonne santé âgés de trois à cinq semaines On a produit une ton pur d'une qualité uniforme à 4 degrés d'intensité et à 7 hauteurs. On a évité la production et la cessation soudaines du son, ainsi que les effets de fatigue et d'apprentissage On a observé et noté le comportement somatique qui a eu lieu avec le stimulus ou directement après On conclut que les tons purs de grande intensite et de courte durée ennuient plus les enfants que ceux de petite intensité, ceux d'une grande vitesse de vibration ennuient plus que ceux d'une petite vitesse, les enfants montrent des expressions plus positives et variées d'ennui que de plaisir en réponse aux stimuli auditifs; l'effet d'un stimulus auditif sur un enfant dépend de sa condition physiologique et de tous les autres stimuli concomitants internes et externes, les réactions des jeunes enfants aux stimuli auditifs sont des réponses réflexes non différenciées lesquelles ont rapport défini à l'intensité du stimulus Rien ne nous fait supposer que ces réactions soient causées par l'émotion de peur.

HALLER

DIE REAKTIONEN VON SAUGLINGEN AUF ANDERUNGEN AN DER INTENSITAT UND HÖHE REINER TÖNE

(Referat)

Das Ziel dieser Untersuchung war, systematisch und unter kontrollierten Bedingungen die Anfangsreaktionen von Säuglingen auf Änderungen an der Intensitat und Höhe von reinen Tonen zu erforschen . Es wurden neunzehn gesunde weisse Sauglinge im Alter von drei bis funf Wochen beobachtet. Reine Tone von vier verschiedenen Intensitatsstarken und sieben verschiedenen Hohen wurden geaussert Plotzliche Laute und plotzliches Aufhoren des Lautes wurden vermieden, wie ebenfalls die Wirkung der Ermudung und des Lernens Die somatische Tatigkeit die zusammen mit oder sofort nach dem Reize stattfand, wurde beobachtet und notiert Man fand, dass reine Tone von starker Intensitat und kurzem Dauer auf Sauglinge storender einwirken, als Tone von geringer Intensitat, Tone mit raschen Schwingungen (high vibration rate) wirken storender als die mit langsamen Schwingungen (low vibration rate), die Sauglinge druckten in ihren Reaktionen auf auditive reize mehr positiv und mannigfaltiger Unbehagen als Behagen aus, die Einwirkung eines auditiven Reizes auf einen Saugling ist von seinem physiologischen Zustand und von allen anderen mitwirkenden inneren und ausseren Reizen abhangig, die Reaktionen von Sauglingen auf auditive Reize sind reflexive, undifferenzierte Erwiderungen die in bestimmtem Zusammenhang stehen mit der Intensitat des Reizes. Es leigt kein Grund vor, diese Reaktionen als durch den Gemutszustand der Angst bedingt zu betrachen.

HALLER

AN UNUSUAL OPPORTUNITY TO INVESTIGATE THE PSYCHOLOGY OF LANGUAGE*

From Louisiana State University

C H BEAN

A new approach to the investigation of the psychology of language is supplied by this case, a child who was born blind and gained adequate sight, through operations, during the early stages of speech learning

Lack of vision was due to congenital cataracts. Only enough light reached the retinae around the opaque cores of the lenses for his eyes to turn reflexively to its source. Before the pair of very successful operations at the age of 16 months, all the usual baby-like absorption in the colorful, moving, exciting complexity of the visual world was excluded But this limitation produced in L's behavior a correspondingly larger amount of reaction to the great realm of sounds and their limitless combinations of qualities. This exaggerated interest in sounds as he heard and reproduced them was diminished for a brief period when sight first became possible, but soon resumed the dominant rôle, with the new interest, the world of light, as its able assistant. Every new thing that sight put into his hand was repeatedly drummed against another object or the floor and gleefully listened to, and its name was later added proudly to his vocabulary.

Subsequent manifestation of native talent in music, later rated very high by his music teachers, may have been an additional factor in his early progress in language Seashore tests, given at 11 years of age, placed him in the highest percentile rank in pitch, melody, harmony, and memory, and in the next to the highest in rhythm. All these unusual factors combined to make stages in language learning much more pronounced and isolable for study than in other cases.

The evidence in this investigation consists of records made daily during his first four years, and frequent records thereafter to his twentieth year Degrees of certainty were indicated in all the notes Although attention was not given to language data alone, it was

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limited to the observation of the types of behavior directly affected by the temporary absence of sight and by its subsequent presence The thoroughness of observation that this restriction of the field made possible is in a measure evident in the abundance of the outline notes, which, in that brief form, would cover about nine hundred printed pages.

After his operations, when the charm and novelty of the visual world had worn off, his habit of attending to the other kinds of sensation than visual made L satisfied with any visual impressions that were just sufficient to signify that the object present was of an old or of a new kind, or with no visual impression at all. Nevertheless, he insisted upon the pronunciation of its name The effect of deficiency in sight, therefore, upon L's ability to express himself, as the details of this article will show, was not only temporary retardation of his manual skills, but also, in compensation for this lack, the acquisition of marked efficiency in auditory perception and vocal expression.

After his third month, L, like other children, found no other plaything so interesting or so capable of varied use as his own voice. Limited in most of the other forms of infant play, L imitated a countless number of the sounds that he heard Many persons, even parents of children of L's age, expressed astonishment at the range and the individuality of his repertoire of mimicking noises and the close resemblance to their original sounds. He never said "bow-wow" or "moo" or "cock-a-doodle-doo," but made more exact facsimiles of the animal noises that these conventionalized forms aim to represent If he had learned to creep and to walk before he could see, he could not have spared the time and energy from those employments to learn this long list of cries of birds and animals, roaring of storms, the racket of modern vehicles, and other city clatter.

Sound had such a large place in L's mental life, and the notes were sufficiently complete that it may well be expected that his case will throw a strong light upon the psychology of language and therefore upon the teaching of language arts Theories of language agree that an individual's speech has its beginnings in the vocalizations of infancy, but these sources have not been sufficiently analyzed. Preyer advocated the doctrine that words are the lineal descendants of primordial babblings Sully believes that speech has its origin more largely in the happy, cooing, song-like sounds of babyhood. According to the interjection theory, the cries that manifest emotions in animals,

in primitive man, and in infants become associated with the ideas that are kindred to these emotions. Kirkpatrick says,

> "At first the child has no cry except for pain, and little or no variation in its cry to express different kinds of pain Soon, however, the cry of anger or the wail of disappointment is differentiated from the cry of physical pain At about the same time or a little later, other cries, screams, gurglings and cooings suggestive of energy or of pleasurable contentment are made" (3, pp. 248 ff).

My notes contain evidence that each of these views is but a partial truth. No less than 19 of L's sounds and combinations of sounds were linked each with its large group of closely resembling situations from the time of their first appearance. Even more significant is the fact that several of these connections were clearly evident within a few hours and even a few minutes after birth, too early for any one of them to have been the result of experience For example, there was one cry, a combination of short *u* and short *a*, "uaa, uaa, uaaaa," that accompanied hunger, fatigue, and all other uncomfortable situations and another cry, a union of short *a* and long *e*, "aeeee," coincident with unquestionable causes of pain. When he was 3 months and 2 weeks old *m* was pronounced with perfect distinctness, followed by *uh*, in a new cry, "mmuh, mmmmmmuh," uttered when persistent appeals brought no food. In his case, as in that of two other infants that I studied, this combination of sounds, this innate accompaniment of dissatisfaction, disappointment, and distress developed gradually through the consequence that often followed this cry into associations with mother, that faithful reliever of every discomfort, satisfier of all dissatisfactions The cry, "uaa uaa uaaa," mentioned above, was the earliest that was observed to become modified into two cries (third day). He was so weary that day that the cry sounded like 'w w waa," and was followed by provisions made for rest. This cry thus became differentiated gradually from the other cry, which was followed usually by the supplying of food. At 2 months 1 week 4 days, while happily amusing himself with a sing-song, approaching hunger drifted him into the hunger cry. Thereafter a sing-song hunger cry replaced the usual cry of hunger This left the other baby annoyances with "uaa uaa uaaaa" as their unaltered call Many sounds originated in like manner from the 19 primary ones.

At first all sounds, except perhaps some grunts and clicks, even

those of crying and of fretting, were vowels, because the only organs used were the vocal cords and the open mouth cavity. With the exception of the semi-obstructed cry of fatigue mentioned above, no definite consonant appeared until the last week of the third month, when he was heard in an unmistakable "ha ha" of laughter. The remaining consonants followed each other in slow succession. *T* was sounded for the first time at 6 months 3 weeks, *p* and *k* at 7 months, *d* at 7 months 2 weeks, and *n* at 10 months These observations were verified by the fact that, when a consonant put in its appearance, it reappeared almost hourly.

The record of L's earliest grunts and clicks is not very abundant, but limited early data and more abundant data recorded later indicate that many of the sounds were made while he was fretting and few while he was joyously happy. By the middle of the fifth month he had an astonishingly large vocabulary of clicks, gurgles, and grunts A note was made at 6 months 3 weeks of his grunting, gurgling, giggling, and displaying other vocal and motor signs of happiness while an electric light was repeatedly turned off and on, and a few days later he grunted and occasionally clicked whenever he wished this process to be repeated At 5 months 2 weeks, if his father failed to play with him as soon as he came home from work, L made fretting, sputtering, and grunting sounds. At 6 months 1 week he had the habit of sniffling and rattling his bed, sounds that had awakened his parents and brought them to him This last case and many others in which grunts and clicks and other sounds were associated with specific results that they brought about may serve as an illustration of the manner in which the simplest natural sounds and movements become means of expression. As early as 4 months 2 weeks, when his efforts to regain possession of an object that had slipped from his grasp made him grunt, and the object was promptly replaced in his hand, the reaching and grunting, louder and louder grunting, was repeated after the object had been allowed to slip again and again Likewise, when fretting, apparently weary of being in his cab (5 months 1 week), he raised his body as high as he could with his heels and elbows resting on the cab and accompanied this effort with a guttural squeal, probably the only vocal utterance that was possible while in that position. The relief that was promptly supplied fixed this sound as the habitual symptom of uncomfortableness of posture, and later it became the symptom of ennui with any experience In this manner each grunt and click that was retained temporarily or

permanently became at first the symptom, rather than the expression, of the presence of the need for which this symptom usually brought satisfaction Through similar processes, accidental and natural movements of the face became mere manifestations, and subsequently became expressions of his feelings and emotions.

Young children smile rather early, as did Major's (4) at 3 months 2 weeks L's smiles were at first homely smirkings, but were always immediate accompaniments of satisfaction after a high degree of physical discomfort His first smile of this sort was seen on the second day of his third week, and smiles became increasingly frequent, more easily induced, and more attractive. He could not imitate smiles because he could not see At 2 months 1 week, for example, he smiled broadly when his hand was patted, and closed, then opened the hand each time for a repetition of the pleasing contact. An interesting sound brought the smile response at 2 months 2 weeks Smiles were present on many, many sorts of happy occasions during the first two years When two callers departed and his mother could be free to manifest an interest in him (5 months 1 week), when her songs began, or when she entered upon the last especially rhythmic line of each stanza (5 months 3 weeks), when electric lights were snapped on or off, or later when we imitated his sounds, the smiles were sure to come However, during the last two weeks of his third month and first two weeks of his fourth month, owing to illness and subsequent low vitality, smiles were entirely absent. But he no sooner recovered his usual vigor than the smiles returned But when L first became able to see, he was too busy connecting the now visible world with his already complex, familiar world of auditory, motor, and contact senses to pay enough attention to faces to learn to respond to smiles with smiles It seemed that the non-human environment which was absorbing his attention provoked smiles too seldom to keep their instinctive inclination active, for his smiles and laughter almost ceased By all manner of efforts that could be devised, his parents multiplied his pleasant experiences, especially with people, and permanently revived the smiling, laughing, joyous part of his nature.

Even though little children, like young animals, instinctively seek bodily contact with their kind, in children kissing is undoubtedly a pure acquisition. The pleasures derived from contact, however, made L, like other children, desire to be embraced and less and less unwilling to endure being kissed Finally, with the addition of playfulness in the process, he developed these movements into manifestations of joyous affection by the time he was 3 years old

There is not much evidence to show how shaking of the head in negation, or how nodding in affirmation, are learned When L was 7 months old he began to move his head from side to side in refusing food offered him Occasionally, in order to emphasize his refusal, he uttered a grunting sound with each movement of the head. This sound developed early into "huh-uh." We had carefully avoided all opportunity for him to learn this negative sound by imitation It is said that some children seem to have learned to nod by reaching for food with the mouth This was less possible for L, because he never looked for the approach of the bottle or the spoon, and opened his mouth only after it has been touched, a habit learned before sight was made possible This belated his affirmative nod until his nineteenth month when he was taught it by a friend

In the same manner that the pulling at the clothing of an adult in the desire to be lifted up becomes reaching, and becomes beckoning and gesturing in most children when the adult is somewhat farther away, so the opposite gestures and the clicks and grunts that accompany disgust grew in L much more evidently out of the act of pushing things away than out of the facial attitudes accompanying the ejection of disgusting substances from the mouth

L's reliefs, satisfactions, and joys did not begin to be accompanied by sounds until he was 2 months 1 week 6 days old. He then uttered the long *oo* and short *u* vowels, "oo u," frequently when his wants had just been satisfied. His first laughter, an unmistakable "ha ha," referred to above as the first sound containing a consonant, occurred at 2 months 3 weeks when his mother was singing while bathing him Laughter increased in frequency from that date to 3 months 3 weeks when it was modified by the greater heartiness with which he laughed into "ha ha ha uh" (inhaling on *uh*).

There was a clear-cut manner in this child's transitions from the single type of shriek, that is, the baby's spontaneous vocalization with all manner of pains, from the one wail that originally accompanies discomfort of every conceivable origin, from the smile and the *ha-ha* that are the indubitable symptoms that all is well, to the several pain screams, to the differentiated wails that serve the parents as clues to the specific causes of discomfort, and also to the varied smiles and grins, the *ha-ha's, he-he's, ho-ho's,* giggles, and squeals of delight that are evidences of multiplying forms of mirthful emotions. Careful observation of several other children, in the light of these evidences from one child, justified the belief that, although temporary blindness

had made the steps in his vocal language more pronounced than theirs, nevertheless, his progress was like theirs in every other respect This breaking-up of single forms of behavior into many, and the fixing of each as a symptom of a need that requires and gains the proper kind of response from parents is doubtless the method by which all normal childhood differentiates simultaneously its mental life and the fundamental sounds and gestures of its language

Thus, as experiences multiplied, special vocal responses to these experiences became more frequent Because L was limited largely to a world of sound during his earliest months, he paid more attention to sounds than other children with their multitudes of visual interests Whenever the noisy city environment in which he lived failed to entertain him with novel experiences or sounds intrinsically pleasing, as music, or noises that were interesting because of their former relations to him, he occupied himself with haphazard vocalizations or playfully rehearsed one after another of his most recent vocal accomplishments A nasal *u* prolonged and then abbreviated (5 months 2 weeks), *pp*, purely asperate (6 months 2 weeks), "da-de-da-di-ga-go-di-da" (7 months 3 weeks) are types of sounds that he practiced

The desire for social approval is the strongest inducement for a baby to repeat a sound until it becomes a part of his permanent repertoire Children try to attract attention, even before the middle of the first year, by every means available, by their voices, by their smiles, and by facial and bodily antics. Later they practice skills of all sorts for no other purpose than that of making a social appeal. L had a few limitations in this connection because he could neither do many motor acts nor readily see the effects of his sounds or movements upon others But after he found that he could attract attention by means of his voice, his vocalizations for that purpose were exceedingly varied and persistent. Through these efforts to get the approval of others he eventually found that nothing was so successful as the repetition of sounds that he heard, especially those of people who were making sounds at him Although a record dated 2 months 3 weeks stated that he was not interested in the sounds that other people made, another note made at 3 months 2 weeks 5 days indicated a rapidly growing interest in those sounds But his response to sounds began much later. When he was 6 months 3 weeks old, his father shouted from another room in reply to L's shouts. L shouted again and waited until he heard a response. Throughout a long, varied series of this shouting, no tendency was evident on his part to imi-

tate the shouts that his father varied in length, quality, and pitch At 7 months 3 weeks he made modulated grunts to attract the attention of a young woman he liked At the age of 16 months, without suggestions from anyone, he repeated the entire repertoire of his sounds apparently in order to please his father whom he had not seen for three weeks. These are but a few samples of a continuous watching for opportunities to gain the attention of those about him. He made little effort before he was 11 months old to imitate words that were said to him, even in self-imposed language lessons, in which he begged for one object after another to be named. But as early as 7 months 3 weeks he obviously found that his mother was pleased when he said "a-boo" in response to her "peek-a-boo," for he continued it. At 9 months 2 weeks he kept his father's attention by apparent efforts imitatively to say "papa" by making an aspirate sound "p-p-p." He was equally happy at ten months in winning approval with "a-to" for "tick-tock." After he was 11 months old he often tried to imitate words, delighted meanwhile by the approving response, "That's the boy!" Later he became so imitative that his progress was astonishingly rapid In the learning of sounds, in acquiring the ability to pronounce words, and in habituating himself to the structure of English sentences, L's primary motive, without doubt, was the gaining of social approval. Imitation was a means to that end, not an end in itself L would not have imitated sounds or anything else at this stage if he had not gained any reward other than successful reproduction of what he heard, because, although he usually began it without inducement, he stopped the moment the social response ceased to come

Long before L could pronounce a word, he knew the meanings of a great many words. Owing to the fact that children and animals learn isolated words more readily than words that are welded together into sentences, and also because children use words singly at first, we accustomed ourselves to conversation with L in single words or very short phrases He soon discovered that we were pleased when he made an appropriate reaction to each word that we said to him. We predetermined the response by saying the appropriate word for a movement that he happened to be performing, or for the object that he was examining. Thus he formed association links between 152 words and phrases and the objects or acts to which they belonged, before his operations when he was a year and six months old. Some words were symbols for complex groups of relations; some had but

a single relation, many of them merely recalled the objects of which they were the names. No record was made unless three or more repeated reactions proved that the associations were permanent.

L's reactions to the first words in this list depended to a very noticeable extent, while he was learning them, upon the tone in which they were spoken. Low harsh tones caused him to stop whatever he was doing and look alarmed. Gentler, higher tones that succeeded each other *in a melodious order* made *him smile, laugh, and* be *active.* These apparently acquired reactions to a large list of words that usually were spoken with an appropriate tone impressed their meanings much more quickly than others. e g, "no, no," "peek-a-boo," "big boy"

By watching the face of an adult, the child not only learns at this age how to use the vocal organs in speech, but also acquires the emotional attitudes and is aided thereby in grasping the meaning. Owing to his inability to see faces during the first 16 months, and his resultant inability to interpret facial expression, he gained little or no help from visual observation of peoples' mouths while talking As a consequence, his keen mind for sound did not save him from making such errors as "meap" (meat), "grate nuts" (grape nuts), "stean" (steam), "betweem" (between), and even "blessum" (blessing) But as no baby-talk, except a very few such words as "choo-choo cars" and "kitty," was heard, L learned to pronounce nearly all words correctly when he first used them Moreover, he never used *k* for *t* or *t* for *k*, nor did he employ substitutes for *l* or *t*, all of which errors are common among children whose attention has not been keenly and habitually fixed upon sound. This shows that children's mispronunciations are due to crude perception, not to inability to pronounce the elementary sounds.

In L's first attempts at pronunciation he put no more than two letters, a consonant and a vowel, into a syllable, and sometimes failed in doing even this. For example, at 14 months 3 weeks "j-j" was his first attempt at riggi-jig-jig When he was 11 months old, he pronounced correctly, *th*, both subvocally and aspirately; but, because he did not succeed after much self-imposed practice in pronouncing *th*, especially in combination with other sounds in words, he made no further use of it until he was four years old. He often inadvertently pronounced German umlauts, gutturals, and both German and French trills

Like other children, L at first used single words to express each

unit of experience. Chamberlain (1) calls words thus used "rhemes." The rheme is usually treated as equivalent to a complete sentence; but these incomplete units of expression are employed, not because children have few words and little knowledge of the idioms and sentence structure of their native language, but more largely, I am convinced, because their thoughts are correspondingly incomplete. The baby that says "milk," does not mean, "I want a bottle of nice, warm, sweet milk"; for it has never known any other kinds. Therefore, the one word stands for an undifferentiated idea, not an interrelated thought. Besides, "milk" has been the only word necessary to bring this food. As in the case of seven-year-old Helen Keller, no distinction having been made between the milk, its qualities, its container, and the bringing of it, the ideas "warm, sweet, white, liquid," and even of "bring" could not have been implied in the word "milk" Incompleteness, I find, is the most obvious feature of infant reaction I should define a rheme as the expression of a baby's undiscriminated, unqualified, incomplete idea, not of a thought in the adult sense.

Sometimes the most meaningful word would have been a noun in a sentence of an adult, but was more like a verb in the rheme. "Lap" meant to L clearly the act of being put on the lap rather than the lap itself. Likewise, the preposition "over" and the adverb "now" often had verbal significance, and the verb "knock" seemed to have definite reference to the some one, not to the knocking. Therefore, *as Lukens and Chamberlain have said, attempts to classify these* rhemes as to their parts of speech are useless, except as it indicates the following facts: It is the word or words most pregnant with meaning that are favored by vocal stress in adult language and that are therefore seized by the baby as the conveyer of its fragment of thought.

The use by L of more than one word in a single expression was found to mean that the rheme idea was giving birth to other ideas through manifold varying experience. Sometimes the several words constituted a phrase More often they did not One day (2 years 2 months), when a man began working noisily on the floor above, L exclaimed, "Papa–no, Jasper." A few days later he said, "Letter, papa," meaning a letter from papa, insofar as he was able to have that thought "Up" became "stay up" He used rhemes in commands, entreaties, and other emphatic matters, in imitation of adults, no doubt, long after he had found them inadequate to express his richer thoughts.

Rhemes that stood for ideas derived from tactual, auditory, gustatory, and motor senses and the few visual ones that related only to light and color, which was all that he could sense before the operations, constituted nearly 90% of his early vocabulary. When his sight led him to explore also the realm of vision and to be more active, words that refer to visual objects were rapidly added and, in proportion to their increase, the rate of accretion of the other types of words decreased There was also rapid enlargement in the tactual-motor, the auditory-motor, and the visual-motor vocabularies because of this greater amount of movement It is evident that, although varied experience adds to the vocabulary proportionately to the widening and deepening in experience, the addition of a valuable sense temporarily reduces the contributions of the other senses, but subsequently combines their results with those of the new sense and thus multiplies concepts and their word symbols

L sought new ideas for new words and new words for new ideas with great zeal, and if they were not supplied, he invented words for ideas that he wished to express, and ideas for words that he heard Late in the fifth year he called a sunbonnet an "apron hat," a towel he spoke of as a "wipe-it-dry," and a convict's uniform a "zebra suit." On seeing an elevated railway train for the first time, he shouted, "See street cars upstairs" Also he interpreted and misinterpreted many words He was always disappointed when he was unable to learn the name of a person, place, or thing that appealed to his interest He appeared to feel that if he knew the name, he was master of the thing named This seems to be characteristic, not only of children and savages, but of all men. Few adults have rid themselves entirely of the tendency to be mystified by words, especially by words that are hard to understand, and they are inclined to judge any unusually clear discourse on a subject that is known to be deep as lacking in penetration

A word was not recorded as part of L's vocabulary until he had used it properly several times It was not considered necessary to omit from the list any word because his knowledge of its meaning was incomplete Proper nouns are more difficult to learn than common nouns, but are available as means of expression, and are therefore included As the words *am, was, been,* and *good, better,* and *best* are distinct lingual achievements, these and similar words were recorded as separate Many children do not know that such words or even their ideas are closely connected until they study formal grammar

The recorded number of words in L's vocabulary at three years was 1149, and at three and a half years the number of words was 1896 In the 46 vocabularies found by Waddle (5), the average size of the eight vocabularies of children three years old is 1407, with a range from 631 to 2282. Therefore, I am convinced that Waddle's are a somewhat select group of vocabularies from children of educated families, families in which attention was given to vocabulary building We made an effort not to boost his language, but to supply only the words that he sought. Chamberlain (1) is no doubt approaching the norm for children generally when he gives the average of children three years old as 642, for Whipple's (6) child, who lived with two educated parents and was encouraged in every way to acquire words and their meanings, is a good example of the select group and had a vocabulary of 1177 words at three years Humphrey's (2, p 6) child acquired 1127 under like conditions. Vocabulary studies give indubitable evidence that there are marked individual differences in the number of words. These dissimilarities are due probably to unlikenesses in richness of experience, to consequent number of interests, to opportunities to associate with educated adults in such a way as to widen the experience and the vocabulary and with children with whom to deepen word impressions, and whether the adult companions are educated enough to have abundant words and are inclined to encourage and assist in the making of ideas as well as the association of them with their symbols. The accumulation of words is clearly a cause and an effect of a corresponding growth in ideas, and in their interrelations

Children, like primitive peoples, have at first not more than one pronoun and no distinctions of number, of gender, or of person. In fact, children are at first not inclined to use pronouns until they have become accustomed to nouns in sentences. L used pronouns without specific number, gender, or person when he was 22 months old. A little later he discovered the difference between you and I, but soon forgot it, evidently because his thinking and use of language were too immature as yet for the advantageous employment of the personal factor. He practiced plural and singular use of nouns at 2 years 3½ months. Singular and plural number in pronouns were acquired immediately afterwards without difficulty Here is another case of the concept and the form appearing simultaneously As we refrained from assisting him until interest in person and gender reappeared, he called himself "he" and "you" in imitation of our conversation about

him and to him, but occasionally spoke of himself as "I," "me," and "she." He sometimes used pronouns at this stage with reference to other people; but, like other children, he usually employed nouns. He began by referring to his father as "papa," "he," "she," or "you" Briton says that most children use *me* in referring to themselves Insofar as this is true it is probably due to the fact that, although *I* is used by adults more frequently than *me*, *me* is more often pronounced with emphasis. L was often heard trying to puzzle out these relations When he was nearly three years of age, he used *I* constantly in talking about himself to an adult friend, but after his departure, he said, "You mustn't say 'she' for a man and 'she' for a woman." One day he evidently believed he had solved the gender problem with regard to Chicago, for he excitedly exclaimed, "It's not 'Hecago,' it's 'Shecago!'" During this period of interest in gender, person, and number, without anyone's suggestion, he said hesitatingly, "I jumped, you jumped, she jumped, me jumped, they jumped, her jumped." He had never heard anyone conjugate, decline, or do anything in formal grammar before this utterance; but, as he seemed to be ready for it, assistance was given then in straightening out these difficulties His readiness was evident in his seizing of every opportunity to put into practice everything that he was taught and in the self-imposed drill in which we often heard him giving such sentences as, "He said that I might have his French harp, if I don't bite it with my teeth." One day, just after the fundamentals of gender, number and person were in proper daily use (3 years), he was watching the preparation of a familiar rooster for roasting, and, as the oven door was finally closed, he exclaimed, "When he's cooked, he won't be he: he'll be it." This, as I see it, is evidence that the drill was timely, for he was linking it with experience.

Owing to L's interest in color, because it was often visible before he could see objects, adjectives that designated the colors of objects became part of his vocabulary during the ninth month of the second year, whereas other types of adjectives were noticeably few until much later These facts coincide with other data that indicate that (despite adult obtrusion of qualities into the experience of children) they are so busy acquainting themselves with objects and their uses that the qualities of objects play a less important part in their mental life, and therefore in their language, until there is a large enough fund of nouns, and until the nouns are familiar enough to lend definiteness of meaning to their modifiers Comparison of adjectives became possible almost as readily as use of adjectives, strange to say

Adverbs were added much more slowly than adjectives. Verbs were multitudinous and familiar before adverbs were used. "Here" and "there" were distinguished by the middle of the twenty-fourth month At 2½ years "yesterday" meant past time in general, and "this afternoon" referred in the same indefinite way to future time. Later "tomorrow" signified some time after today. It is possible that our English idioms, "the day before yesterday" and "the day after tomorrow," being too complex for the child to grasp early, confuse all references both to past time and to future time. At 4½ years, when his ideas of space had outgrown his vocabulary temporarily, he met his needs with such inventions as "farer" (farther) and "be-yonder" (farther yet).

Strange to say, L used almost no natural or conventional interjections. He expressed his emotions, which underwent rapid development between the ages of 16 months and 4½ years, by modifying the quality of his voice, or by two or three such expressions as "goody-goody," and by movements of excitement This was because even the less objectionable interjections were never heard by him, not because he was unemotional.

Studies of childhood indicate that collective ideas, generalizations, and concepts develop more slowly in children's minds than one would infer from casual observation. Children are often observed reacting in a similar manner to objects of the same class or to circumstances that are only similar as though they have class ideas. There were evidences in this case that early reactions of this sort and many of the later ones resulted from failure to discern differences rather than from the ability to discover similarities and form them into concepts. It seems difficult for a child to learn when an idea that fits one case will fit another that has some factors that are like and some that are unlike the first case. At the middle of the sixth month, for example, L learned to refrain from playing with his bottle in an objectionable manner whenever he heard "no-no." Later when he heard "no-no" while he was irritating his eye with his finger, he looked puzzled, then laughed, but did not discontinue the undesirable act until his mother drew his finger away. Thereafter he inhibited either of these two acts whenever he heard "no-no", but it was necessary for him to learn several more inhibitions, one by one, before he succeeded in making this into the idea of quitting whatever he was doing when he heard "no-no." He perfected his generalizations of some things about the middle of the fourth year by monologues of

the following kind: "Jelly isn't black. it's dark red." "The piggy went to market at six o'clock, not seven o'clock." "Is it about noon or pretty near noon?" "Did you say perhaps we would go, or maybe we would go?" "If you think so, it is better than if you suppose so." No doubt the conscious, analytic manner in which L realized many of these distinctions is due to the unusual interest he had in the world of sound and language; but observation convinces me that all children learn language in a similar but less obvious manner.

Soon after L was 2 years old he became more interested in combining his own words than in the acquisition of new words. As a natural consequence, the structure of his sentences appeared more and more that of sentences "Go home get toast," and "Looking down on street," are expressions selected from those used when he was 2 years 2 months old. After he had become able to use complete sentences, however, he seemed to find it necessary to use them *in order to be explicit while talking to another child, but continued* to talk to adults in less complete sentences. Interest in new words alternated with interest in sentence structure at varying intervals Sentence building was especially dominant in the early part of the fifth year. The word periods seemed to coincide with the widening of experience through travel and other eventful additions of ideas, and the sentence periods were the uneventful interims in which former happenings were remembered and were reconstructed by imagination If it is true that children improve faster in language through their association with children, as is supposed, than through contact only with adults, one of its causes is the necessity for the more adequate expression of their thoughts that are intended to be understood by children. But surely the fastest progress can be made with the presence of both children and adults, because adults supply the new words and the sentence models and idioms, while children are stronger stimuli for conversation about things interesting chiefly to children

Before this period of sentence building, L's early questions had begun They made their first appearance, of course, in the theme stage. "Telephone wires?" was a question of this type (2 years 2 months). Later he often asked a question in the form of a declarative sentence in which one or two words were omitted to be supplied by the answer. By the third month of the third year his questions began to assume such proper forms as "What's that?" During the fifth month of his third year he also answered a few questions properly

As soon as L could use sentences, an effort was made to teach him to carry on conversation. But this confused him. He repeated the questions asked him, word for word (2 years 3 months), and in response to "Good-bye, L," he said, "Good-bye, L," and later replied to a question with an answer in interrogative form. One day he described what he had seen down town (2 years 5 months) in the following manner "Did you go down town on the street car? Did you see lots of people? Did you hear band music? Did you ride home with Mrs. M in her automobile?" He often told stories partly in interrogative and partly in declarative form in imitation of the semi-conversational manner in which the story had been talked over with him. The recovery from this result of slavish imitation was brought about by catering to the imitative propensity by his having questions put to him and all the possible answers suggested in declarative form. He readily stated his answer then in a declarative sentence, and soon developed an interest in wording his own answers in declarative form, and later spent hours in monologues like the following: "Is salt-box broken all to pieces? No, it isn't broken all to pieces; it's broken only on top." Anyone who listens to the self-amusement talk of any child in its third and fourth years will hear this kind of imitative practice of the sentence forms that are being acquired, and will see in it the close adherence to copy that first misled and then usually led aright this little learner

Successful teachers of foreign languages assert that the chief difficulty encountered in the teaching of foreign languages to adults is their insistence upon rational learning instead of imitative practice. Every effort of the teacher to explain perpetuates in his adolescent or adult student this ineffective language-learning habit A minimum of discussion of the language being learned, as few rules as possible, and as much mechanical imitation of the correctly spoken language as time will permit and repetition of assignment produces the best results with adults as well as children until thinking in the new tongue about common things has become readily possible.

When L was 2½ years old he begged to hear his favorite stories and songs, not by titles that he knew, but by telling part of each story. For example, he said, "Sing about 'Rock-a-bye baby on the tree top, and when the wind blows the cradle will rock, and if the bough breaks the cradle will fall' ", or, "Tell about 'There was a little baby It didn't have any bed. It lay in the hay. The cows stood around and looked at the baby. The baby's name was Jesus.

It was a long time ago on Christmas.' Tell that story." The greater originality of the wording of the second descriptive title was due to the fact that this story had not been given to him in the same words twice, whereas the words of the stories read to him and the songs were, of course, fixed.

L did not always insist on the exact repetition of the original words of stories as most children do, because many stories were told in different words and in greater and greater detail as soon as L had grasped the most fundamental incidents. The purpose of this procedure was, of course, the avoidance of unoriginal, mechanical habits like those out of which he had previously been led and the development of the proper balance between imitativeness and originality. It was surely owing to this training that he became able to either repeat word for word or to relate with a considerable degree of originality. At 2 years 6 months he told part of the story of "Three Bears," with here and there an original touch: "Mama bear made some soup—bean soup. Had to wait to get cold. Papa bear said, 'Somebody has been sitting in my chair.' Papa bear said, 'Somebody has been tasting my soup.'" A month later he told it as follows: "Well you know there was a papa bear and a mamma bear and a wee, wee baby bear. And the mamma bear made some soup, and it was hot. So she said she thought they'd better take a walk down to the park, and wait for the soup to get cold. Then they put the baby bear in his cab and took him down to the park." When he was 3 years old, he told the entire story to his doll with intentional modifications that deviated farther and farther from the original form until the meaning was too different to be interesting. He then omitted that story for some time.

Summary

The seeds from which a baby's language grows are more numerous than is usually believed. One of them is a cry, manifesting needs and discomforts. Another is an indication of pain. Several are the frettings, sputterings, and clicks, and the wails of impatience. There are grunts of exertion. There are vowels of gurgling and of sighs, when comfort replaces discomfort. Then the *ha-ha*, *he-he*, and *ho-ho* of more and more hearty laughter, and the giggles and squeals of delight. Nineteen sounds give much evidence of being primordial.

At first, these are not, in any sense, expressions, but only natural manifestations of the conditions that accompany them. But adults

supply the needs that these sounds reveal, until the need, its manifestation, and its satisfaction become conjoined, somehow, in the little one so that, when the satisfaction does not arise in its turn, fretting and sputtering come with other evidences of impatience. These sounds become calls for assistance, but it is impossible to tell exactly when this transition from manifestation to expression takes place, for it seems to dawn, rather than to flash into the young mind.

In the meantime these primordial utterances become modified, conditioned, and reconditioned Two organic needs present themselves simultaneously, or a need arises while sounds are being made for their own sake, and its natural sound blends with the play sound that happened to be coincident with it. After an older person gives a baby the object that it is straining to get, the grunting that accompanies the baby's effort becomes the semblance of a request. Thus the many primary sounds become differentiated.

Variety of its own vocalizations is sufficient to interest a baby in its sounds, whether play with sounds is innate or not. Pure vowels are easiest to make and occupy the whole waking time at first Then accidental closing or opening of the tongue or of the lips on a vowel adds a consonant, then another and another, to the vocal playthings. Vowels and consonants are thus in syllable-like unions

The number of sounds that ultimately find a place in this self-imposed practice is astonishing. One cannot fail to hear all the vowels and consonants, diphthongs, aspirates, sub-vocals, nasals, German umlauts and tongue trills, French throaty trills and grunts, and even the Welsh *l*.

Then these syllables are rehearsed in grotesque mixtures. During the repetition of a syllable, or the utterance of one of these random series of syllables, someone discovers its resemblance to a word and the infant is rewarded by joyous fondling This gives the kind of permanence that insures its recall under similar environmental circumstances Although to the adult it is a word, to the child it doubtless lacks the most important essential of a word-meaning

The mastery of syllables in every conceivable order puts the little learner in readiness to imitate If no other imitation is innate, there is considerable probability of its being inborn to imitate sounds, for it was demonstrated in this case that it cannot be taught Every possible effort was made to induce imitation of sounds that L had mastered, of new, simple sounds, and of animal and of human sounds, but in vain. In several cases that I have observed in families and in

orphanages, imitation began in both the tutored and the untutored immediately after syllables could be pronounced in every order. Then imitation monopolized L's day

L was interested in another's conversation at 3½ months, shouted in response to shouts, with no imitation even of changes in pitch or loudness at 7 months, and he imitated profusely at 11 months

Words were used by L neither as words nor as sentences, but as fragments of language that symbolized fragmentary thoughts Usually they were the part of a sentence that adults emphasized. The differentiation of elements in an idea, or the relating of an idea to another was followed promptly by an attempt at its expression For this reason, any enrichment of experience, such as a journey, always greatly increased his vocabulary. On the other hand, whenever L acquired a new word, he begged for its meaning His development in language and in ideas not only accompanied each other, but thus kept step with and stimulated each other.

It is futile to try to determine when each grammatical class of words begin to accumulate, because a rheme gradually, after several stages, ceases to be a rheme and becomes a word

The sentence was most interesting to L and was improved most in the early part of the fifth year

He continued to talk to home folks in rhemes for some time after he used sentences in talking to children and new adult acquaintances. Whenever the satisfaction of his desires depended upon clear statements, his conversation was more correct than at other times.

Contacts with adults added to his vocabulary and to his sentence forms and ideas and thoughts, and association with children increased the rate and efficiency of his self-expression.

Whenever the environment supplied few new ideas, L utilized the time in the practicing of recent acquisitions, but he made less progress than he did when necessity put it into use.

L asked questions in rheme form before he could use sentences, nevertheless, the questions asked by others confused him for a long time He practiced many times talking to himself in a queer mixture of declarative sentences and interrogative sentences without answers Then he repeated the questions of others, word for word, with evident effort to answer in the affirmative. Finally, he mastered question and answer conversation as though its secret had suddenly revealed itself to him

Qualities of objects are uninteresting to little children until their

time is no longer consumed in discovering the names of the objects in their environment, and what these objects do. Adjectives and adverbs multiply almost simultaneously, adjectives faster than adverbs.

Tomorrow and yesterday persisted for a long time in referring to indefinite future and past time.

Number in L's pronouns was evident as early as it appeared in his nouns.

Comparison of adjectives was present by the time some of the rhemes had assumed genuine adjective character.

Confusion of similar things is often mistaken for generalization, which develops very late.

It is evident that all children learn language by an identical procedure. They master, in succession, vowels alone, consonants in syllables, series of syllables, rhemes, words, phrases, declarative sentences, and interrogative sentences.

Early words refer to objects, later ones to actions, and then appear words assigning qualities to things and modes to acts The forms of nouns and pronouns, of verbs, of adjectives, and of adverbs are acquired with them with their uses without any help from rules.

The fastest progress is made in the learning of language through its use, but throughout this was distributed a considerable amount of self-imposed practice

A few decades ago, when Latin was the only language of classroom and campus, and today in some schools, students have been persuaded to ignore the fact that they are "high-browed" adults and have learned a new tongue exactly as do little children. They have applied grammar once in a while only as a test of correctness, have omitted translation, and have mastered the language largely through its practical use in the study of other lessons and in supplying their daily needs. Thus they have formed the desirable habit of keeping attention, not on the tool, but upon its work, and have gained much better and quicker results

References

1. Chamberlain, A. F. The child: a study in the evolution of man. London: Scott, New York Scribner's, 1900 Pp. xii+498
2. Humphreys, W. A contribution to infantile linguistics *Trans Amer Philol. Asso*, 1880, 9, 5-17.
3. Judd, C H Psychology: general introduction New York, Scribner's, 1907 Pp xii+389.
4. Major, D. R. First steps in mental growth, a series of studies in the psychology of infancy New York Macmillan, 1906 Pp xiv+360

5. WADDLE, C W An introduction to child psychology. Boston, Houghton Mifflin, 1913 Pp. xvii+317.
6. WHIPPLE, G M, & WHIPPLE, MRS. G M The vocabulary of a three-year-old boy with some interpretive comments. *Ped Sem*, 1909, **16**, 1-22.

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UNE OCCASION EXTRAORDINAIRE POUR L'INVESTIGATION DE LA PSYCHOLOGIE DU LANGAGE

(Résumé)

C'est une étude d'un enfant dont les premières étapes dans l'acquisition du langage ont été très évidentes à cause d'un grand talent musical, à cause de cécité congénitale, et à cause de l'acquisition d'une vision presque normale, dans la dernière partie de la petite enfance. Ce cas nous donne beaucoup d'évidence que 19 sons sont innés La dependance des personnes plus âgées s'est montrée le premier facteur, l'imitation le deuxième, et l'exercice imposé par soi-même le troisième facteur du conditionnement de ces manifestations naturelles de nécessités physiques en expressions verbales de besoins physiques, mentaux et sociaux Avant que la configuration primordiale, obscure, emmêlée, de n'importe quelle chose ne soit devenue changee en formes plus claires, son expression en a été loin d'être une phrase ou même un mot Jusqu'à ce qu'il ait découvert par expérience que quelques types d'objects et quelques types d'actions ont été surtout satisfaisants, il n'a exprimé des distinctions adverbiales ni celles de l'adjectif, ni n'a modifié les formes des mots pour la personne, le nombre, et le temps, ni n'a changé l'ordre des mots d'une phrase pour faire une question Donc un petit enfant apprend une langue plus normalement qu'un adulte, en la faisant servir ses buts, avec son attention non sur l'outil mais sur la tâche

BEAN

EINE AUSSERGEWÖHNLICHE GELEGENHEIT, DIE PSYCHOLOGIE DER SPRACHE ZU UNTERSUCHEN

(Referat)

Der Verfasser untersuchte ein Kind bei dem die anfängliche Sprachversuche wegen aussergewöhnlicher musikalischer Begabung, angeborener Blindheit, und des Gewinns, in der späten Kleinkindheit, von fast normaler Sehkraft, besonders deutlich waren. Dieser Fall bietet beträchtlichen Beweis dafür, dass neunzehn Laute angeboren sind. Die Abhängigkeit von Erwachsenen erwies sich als der erste, die Nachahmung als der zweite, und selbst-auferlegte Übung als der dritte Bestandteil bei der Umbildung von natürlichen Offenbarungen körperlicher Bedürfnisse in wörtliche Äusserungen körperlicher, geistiger, und sozialer Ansprüche. Ehe sich bei ihm die primitive, flüchtige, verwirrte Gestaltung irgend eines Gegenstandes in mehr bestimmte Gestalten aufbrach war seine Äusserung darüber weit davon entfernt, ein Satz oder auch nur ein Wort zu sein. Nur als er durch Erfahrungen entdeckte, dass gewisse Sorten von Gegenständen und gewisse Benehmensweisen besonders befriedigend waren, äusserte er abverbiale- oder Eigenschafts-Unterschiede und modifizierte er die Form der Wörter nach Person, Zahl, und Zeitform und die Anordnung eines Satzes um eine Frage zu stellen. Ein kleines Kind lernt also eine Sprache auf mehr normale Weise als es der Erwachsene tut, indem das Kind die Sprache seinen Zielen dienen lässt und die Aufmerksamkeit nicht auf das Werkzeug sondern auf die Aufgabe richtet.

BEAN

SHORT ARTICLES AND NOTES

A NOTE ON PUNISHMENT AS A DETERRENT IN ANIMAL REACTIONS[1]

C J. WARDEN

The general proposition that punishment operates as an important deterrent to animal activities would seem to require no special proof The influence of punishment in this regard is obvious from the casual observations of our common experience Perhaps this fact can best be accounted for along the lines suggested by Herbert Spencer He held that painful stimuli are quite likely to be also noxious stimuli and hence harmful to the organism The tendency to react away from stimulations of the punishment sort would thus evolve in connection with the tendency to avoid noxious stimuli The individuals and types which did not evolve along both lines would be less likely to survive than those which did This principle must certainly apply insofar as punishment-noxious stimuli are related to responses of pressing biological significance

It may be well to remark that the term "punishment" need not be regarded as definitely subjective In animal studies, we define a punishment type of stimulus as one which elicits an avoiding response from the organism In human psychology, and particularly in the social sciences, the term usually connotes some form of physical pain or mental anguish We shall use the concept of punishment in the present connection in the former and more restricted sense when infra-human organisms are intended As thus interpreted, the Spencerian dictum comes down to this that the capacity to discriminate and avoid certain classes of stimuli may be regarded as necessary to survival That this is true, and that organisms as now evolved find it as natural to avoid some stimuli as to approach others can hardly

[1]Read before the 9th International Congress of Psychology Yale University, New Haven, Conn , 1929

be denied by anyone competent to entertain an opinion on the matter Nor is this to deny that the specific stimuli, or classes of stimuli, which come to be *avoided or approached by a given species are largely determined by* the individual experience of the organism within its limited life history It is the general capacity to discriminate among objects of the environment and to make negative-positive responses along lines of biological fitness and individual comfort that have been evolved The particular signs of the harmful and painful, on the one hand, and of the biologically fit and comfortable, on the other, must, in most cases at least, be linked up with avoidance and approach respectively through individual contact—that is, these connections must be learned.

The problem of the deterrent effects of punishment on animal reactions thus narrows down to the operation of punishment within the learning situation as studied in the laboratory or as observed in the larger laboratory of nature And here it should be noted that the ordinary learning experiment can offer little of value so far as punishment is viewed as a deterrent to behavior within the social group For the basic technique in learning experiments requires that, in most cases at any rate, a single animal be studied at a time, well isolated both from others of its own species, and from the human experimenter It is true that in certain animal societies punishment, and even the death penalty, is inflicted on members of the group guilty of what appears to man to be anti-social conduct. But there are few if any such instances in which the social structure of the animal group is sufficiently well understood to make valid and useful interpretations of such acts of punishment. This is especially true in insect societies, where indeed the most complex social organization exists, but where interpretation is most difficult because of essentially important differences in the social structure from any human society.

Limiting ourselves to laboratory studies dealing with the relation of punishment to the modification of behavior in the sense of the development of inhibitions, several important general conclusions seem to be firmly established. It is, of course, impossible to cite the evidence in detail upon which these conclusions are founded, but in general such evidence is fairly abundant and involves a reasonably wide variety of experimental situation

1 Such deeply ingrained and supposedly unmodifiable responses as are ordinarily classed as tropisms and instincts can, by the use of suitable modes of punishment, be reversed from positive to negative with a fair degree of ease. This is true even of insects in which such reactions are relatively firmly fixed. It is probably characteristically true with respect to all sorts of animals

2. In discrimination reactions, involving the response of approach to one stimulus of a pair, and of avoidance of the other stimulus of the pair, the use of an appropriate punishment with the latter stimulus is a great help in setting up the habit, and the limits of discrimination ability of an

organism to within a given modality, or phase of a modality, can scarcely be determined without the use of punishment, as thus indicated. The habit of discrimination is more easily established when reward is given for a correct response and punishment is applied for an incorrect response. But punishment alone works better than reward alone, which suggests that avoidance responses are more easily set up than approach responses. In fact, it is almost impossible to secure discrimination in animals under ordinary laboratory procedure without introducing some form of punishment. The high value of punishment as a deterrent to animal activities is also shown by the fact that only light punishment can be used at all. Severe punishment tends to condition the animal against the entire apparatus so that it refuses to work further at the task.

3. In habit formation of the sort involved in the learning of mazes, problem boxes, etc., which are the stock in trade of the animal psychologist, the use of punishment in connection with reward hastens very markedly the fixation of the pattern response involved. In fact, here again punishment in some form is practically always necessary in the setting up of the habit. Furthermore, as in the discrimination type of experiment, the use of severe punishment results in conditioning the animal against the apparatus so that further work is impossible. This is especially so in the case of the higher animals in which a proper emotional attitude is essential to successful experimental procedure. The truth seems to be that punishment, even more than reward, is effective in the control of behavior, so far as animals are concerned. The resort to punishment and prohibitions in the case of the human child in the earlier formative years suggests a similar conclusion in this field. And this is precisely what we should expect, for the genetic approach to the problem leads naturally to the supposition that an organism would evolve special sensitivity to harmful and uncomfortable stimuli.

The bearing of these findings on human psychology insofar as social behavior and crime are concerned is by no means clear. For we should not forget that in the animal experiments from which these conclusions were drawn actual bodily punishments were used. As a matter of fact, however, corporal punishment has long since been banished from criminal procedure; indeed, restraint rather than punishment has become the dominant note in social correction. Nor can we conclude that, inasmuch as actual physical punishment is an effective deterrent in setting up animal inhibitions, we have here grounds for the reinstatement of corporal punishment in dealing with human crime. For the ordinary treatment of such domestic animals as the dog and horse indicate quite clearly that corporal punishment is often less effective with the higher animals than are such secondary punishments as may be administered by gesture, facial attitude, or vocal expression.

In the application of theories of punishment to man, we must recognize the fact that social values and such secondary modes of correction as may

be based thereon are of first importance Dishonor, social ostracism, and the like may well be factors of greater consequence in human control than are punishments involving actual bodily pain The results of animal experiments in which corporal punishments are used cannot, then, be carried over directly to human society in which a new set of cultural values has been evolved.

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A STUDY OF THE LEARNING PROCESS IN THE CAT IN A MAZE CONSTRUCTED TO REQUIRE DELAYED RESPONSE

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A series of mazes possessing different initial and terminal elements but common central elements has been devised in the Psychological Laboratory of Brown University for use in studying the learning processes of the rat, cat, and human individual. The present preliminary note records the results of a training series carried out with cats in one such maze[1]

The accompanying diagram shows the arrangement of the apparatus The maze passages were constructed of wire poultry netting, one-inch mesh, fastened to wooden frames The passages were 8 inches wide and 18 inches high The doors 1, 2, 3, and 4, also of poultry netting, were made to be raised and lowered as slides

The total unit may be considered as consisting of two mazes. When door 1 is open, the reward can be secured only by passage through door 4 this may be called Maze I When door 2 is open, the reward can be secured only by passage through door 3 this would be Maze II

The initial training series, carried out with a number of cats, consisted in training each animal to traverse without error either Maze I or Maze II After the animal had mastered one maze, it was trained in the other When it had mastered both mazes, regular alternation was begun The animal, that is, learned to go first through Maze I, then Maze II, then Maze I, and so on, the animals satisfactorily learned this procedure

After the habit of regular alternation had been established in the animals, a training series was begun in which Mazes I and II were alternated as a coin was tossed. Thus, Maze I might be opened three, four, or five times

[1]The writers wish to express their gratitude to Mr F E Winkler, who constructed one form of the apparatus and carried out the preliminary experimental trials, and to Dr. C K. Trueblood for continued advice during the experiment.

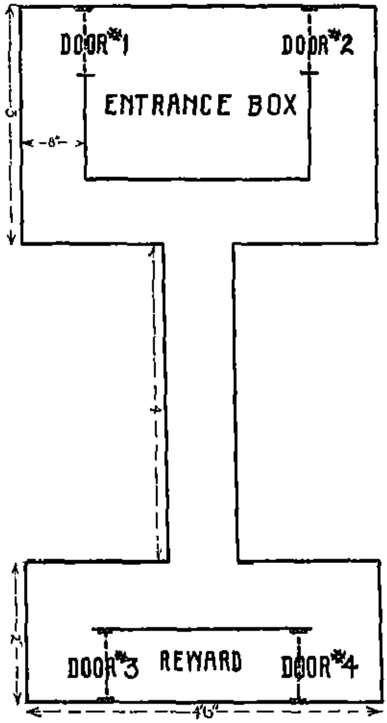

FIGURE 1

successively before Maze II was used In a long series, however, the two paths were used an approximately equal number of times[2]

Experimentation took place with the animal alone in the experimental room, the maze apparatus being manipulated entirely by means of controls from the room adjoining The cats were observed through a small opening in the partition, covered with two layers of fine-mesh screen wire painted white This arrangement provided virtual "one-way vision"

The animals were without food for approximately 20 hours preceding each day's trials. During the trial series they were permitted to eat a small quantity of the reward, canned salmon, after each correct performance

[2]M O Wilson (5) has devised a maze that is basically similar to the one reported here. In his work with the rats in this apparatus, a fact, unsuspected in the present experiment, comes to light, which suggests that a homolateral path (from door 1 to 3 and 2 to 4) might have been more readily learned than was the present heterolateral path

The salmon was placed in a small dish located at one end of the maze (see diagram) It could thus be both seen and smelled by an animal in the entrance box, or in the passages of the maze, if the receptors of the animal were effective at the distances involved

The duration of the experiment was approximately 14 months The training series described was begun with a number of cats, but, because of sickness of the animals or other accidents, was brought to a conclusion with only one. The following table summarizes the performance of this animal *(a young male) in the problem.*

> Total number of trials, Maze I alone, 168 Considered as learned when 32 consecutive successes were noted.
>
> Total number of trials, Maze II alone, 154. Considered as learned with 22 consecutive successes
>
> Total number of regular alternations, 148. Considered as learned with 34 consecutive successes.
>
> Total coin-alternation trials, 144. Considered as learned with 48 consecutive successes

The average length of time for each trial was 11 1 seconds, with a mean variation of 3 seconds

It is unfortunate that more animals were not trained. The results given in this preliminary note must, however, be taken as valid for the one cat that did learn the problem They, of course, show nothing save by inference in regard to the learning ability of cats in general

On the basis of the results secured, the following summary of findings may be presented.

1. It is shown that a relatively complex maze may be used in experimentation upon the learning process of the cat.

2 It is possible for a cat to learn to turn to right or left at the end of a common alley in a maze, depending on whether it has entered the alley from right or left. No body orientation in the common alley could be detected.

3. The conditions of the experiment thus demonstrate that the cat can learn a problem which involves "delayed response" to a stimulus situation given at a previous time

4 The complete protocols of the experiment show that in each of the four stages of the experiment noted above acquisition occurred gradually The curves of learning show a gradually decreasing number of errors as the habits were established No objective or in any other way discoverable "moment of insight" was seen in this process

Theoretically, these results seem to have significance D K Adams, a most thorough experimental student of the learning process in cats, recently made the following observation "Cats gave evidence of continual use of tied ideas, common use of explicit ideas, and occasional, but rare, use of free ideas (1, pp. 160 ff.) He also quotes with approval Tolman's conclusions which include the statement that all learning may be said to in-

volve the representation of the ends of acts at moments before their actual occurrence (4, p 51)

Adams also quotes favorably the conclusions of Hobhouse, which involve such concepts as "practical ideas" (2, pp 302-306) On the basis of his agreement with *Tolman and Hobhouse, Adams concludes his monograph* with the sentence "Apparently psychological unanimity is not impossible" (*1, p 162*) *The present experiment seems to the writers to present evi*dence, as summarized above, that is, in certain respects, disturbing to this hoped-for unanimity

Adams criticizes the experiments of Thorndike, most of the conclusions of which consist in denying certain relatively high functions to animals (3, p 67)

So far as the writers can determine, there is, in the present experiment, no evidence which would necessitate the postulation either of "ideas" or the "representation of ends" The experimental situation, it would seem, was almost wholly novel to the animal, and in the adaptation which it finally developed to that situation there appears nothing which cannot be described entirely in terms of the mechanistic processes inadequately termed "trial and error," with gradual fixation of the "successful response" (so called from the standpoint of the experimenter)

The experiment is accordingly believed to be more typical of learning than are most of the experiments of Adams, which deal, apparently, not with learning, but with the application of past learning to situations that are only partially novel to the animal. The results would appear to support Thorndike rather than Adams in denying to animals the higher functions, so termed, in wholly novel situations, situations that is, wherein learning, and only learning, is involved

In subsequent papers, the results of experiments in similar maze situations with rats and human individuals will be presented and a more complete *statement* in regard to the nature of the mechanistically considered learning process, as it is indicated in these experiments and in similar so-called *"delayed response" experiments, will be proposed*

REFERENCES

1 ADAMS, D K Experimental studies of adaptive behavior in cats *Comp Psychol Monog*, 1929, 6, No 27 Pp 166

2. HOBHOUSE, L T Mind in evolution New York Macmillan, 1915 Pp x+469

3 THORNDIKE, E L Animal intelligence Experimental studies New York Macmillan, 1911 Pp viii+297

4. TOLMAN, E C Habit formation and higher mental processes in animals *Psychol Bull*, 1928, 25, 51

5 WILSON, M O The delayed response *Psychol Bull*, 1931, 28, 673

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A NOTE ON BIMANUAL HANDEDNESS

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It has been customary to designate handedness in sweeping, raking, shoveling, spading, and the like in terms of the hand nearer the functioning end of the instrument. Ojemann (9) has recently questioned the propriety of such a description His argument is twofold, first, since the majority of individuals place the left hand down on broom, spade, and shovel, this must be the right-handed procedure,[1] second, when plotted against a curve graphing various degrees of unimanual right-handedness, bimanual handedness shows an increasing number placing the left hand down as the degree of right-handedness increases Ojemann's scaling for bimanual activities is less satisfactory than his method for scaling unimanual activity, but his results are in any case challenging

In a number of ways I find difficulty in reconciling his observations with mine (2). The difference in groups utilized may be important Ojemann worked with children in the grades; my subjects were professional men or women or college students Ojemann recognizes differences in the way in which the arms are used even when in the same relative position, but finds that the work is usually done on the left side of the body when the left hand is down He uses the formula *RRcr* to designate those cases in which the work is done on the side of the body opposite to the lower hand and he apparently reports a negligible number of such cases My percentage for such crossing is much higher. Again, my percentage of left-handed batters would run much higher than Ojemann's I found as high as 17% among superior men and about 10% among inferior men, although less than this amount for women Over 50% of my left-handed male subjects batted left-handed Ojemann found among his 518 subjects, both right- and left-handed, only 24 left-handed batters, or 4 6% An additional 9% more were crossed in batting Haefner (4) reported 30 9% left-handed batting among his right-handed subjects and 60 3% left-handed batting among his left-handed subjects It is difficult to account for such differences in the figures although, no doubt, such factors as age and experiences operate to some extent and also the criteria used in classification

Rife (11) has made the observation that a right-handed individual who bats left-handed almost always places the left hand down on broom or rake or shovel. This is in striking accord with my records Among my superior group of men I found less than 1% (less than 3% for my inferior group) giving the combination *RLR* A group of some 160 left-handed men gave a comparable record, that is, the right-handed batters in this group placed the right hand down in sweeping. Ojemann reports that

[1]If I understand his formulae correctly, Oates's figures are in opposition to the usual reports

ten of his young left-handed batters placed the right instead of the left hand down in sweeping, a very great difference from my figures. Apparently, however, the great majority of his group of crossed batters placed the left hand down in minor operations. I am confident that the combination *RLR* would be found more frequently among unselected groups than among superior adults, although I am not sure of the reason for this.

I have some evidence for believing that the consistent placing of the right hand down in sweeping, spading, and the like really points to a high degree of unimanual right-handedness. For example, a selected group of *RRR* women showed a greater degree of right-handedness in pegging dexterity, and dynamometer tests than did a group of *RRL*-3 women, subjects who not only placed the left hand down in sweeping but also did the work on the left side of the body. A group of *RRL*-1 subjects fell between the *RRR* and *RRL*-3 groups. These subjects place the left hand down in minor operations but work from the right side of the body. Moreover, practice effects in favor of the left as against the right hand were strikingly shown in the case of a selected *RRL*-3 subject given a long practice series (1). On the contrary, a chosen *RRR* subject remained as strikingly right-handed after, as before, the practice. From some points of view, indeed, it would seem that it is only after prolonged practice with both hands that one can *determine adequately the preferred use of the hands in a given operation.*

Smith (13) thinks the conception of nearness "to the business end of the *tool" is without value, since many different movements of the body may be* distinguished within a constant hand position—movements which vary *qualitatively relatively to the nature of the task, in, for example,* light or heavy sweeping. There can be no question that we need more accurate records of just how the two sides of the body perform in bimanual activities. An accurate technique for recording these movements might clear up many obscurities.

The position of the hands in spading is apparently related in some way to the spade foot. Rife (11, pp. 479 f.) says "the foot used in spading is determined entirely by the bimanual dextrality." *LLL, RLL,* and *RRL* individuals use the left foot on the spade, and *RRR, LRR,* and *LLR* individuals use the right foot. My own observations in general confirm those of Rife's, but at the present stage of investigation one cannot say whether the spade hand determines the spade foot or the reverse.

Actually, we know very little about preferred footedness. Uhrbrook (2, p. 339) found 14 boys in a group of one hundred who tapped more rapidly with the left than with the right foot, which fact might be cited as evidence of a 14% left-footedness. Meyer (7) believes that the left leg does the heavy work and the right the light (but skillful) work. Schaeffer (12) concluded from a study of the evidence at hand that, whereas the right arm is longer in about 75% of humans, the right leg is longer in only about 52%. Lund (6) reports for length of legs "39% of left-dominance, 35% of right-

dominance, and 28% of equality" We do not, of course, know positively that functional and structural dominance are associated phenomena. If they are associated, the indications point to the fact that left-footedness is much more common than left-handedness, and if the spade foot determines the bimanual placing of the hands in spading, one would anticipate a large number of individuals placing the left hand down on the spade

Recently Haefner (5) has reported an experiment on footedness in children. He tested dominant footedness by the foot used in kicking, pressing down on a wad of paper, and the foot first advanced in stepping up and stepping off He concluded that "a marked degree of foot-dominance appears in only a small percentage of children" and that "the unimanual activities show a somewhat higher degree of correlation with foot activities than do the bimanual activities" His assumption that pressing down on a wad of paper is equivalent to a determination of the spade foot is questionable

The problem of bimanual handedness undoubtedly deserves more consideration than it has yet received, with, as suggested before, more accurate methods of scoring behavior. It should, however, be urged that there are forms of bimanual activity other than those which have thus far been observed statistically. Offhand, one thinks of such use of the two hands as occurs in dealing cards, playing a musical instrument, applauding, and the like. Many bimanual activities seem to show specialization of function for the two hands. Smith suggests from her study of the use of the hands by the blind in reading point-script that the left hand really functions as a sense organ and that the right hand is superior only as an effector organ Other bimanual activities suggest this same type of specialization, dealing cards, for example It might be thought that in violin-playing the left hand performs a delicate sensory function as opposed to the motor skill demanded of the right hand Possibly in this connection the function of the dominant eye with reference to control of the two hands deserves attention.

There is a curious phenomenon known as synergia which probably deserves some consideration in connection with bimanual handedness In certain pathological cases, the movements of neither hand can be dissociated from those of the other hand. Simultaneous symmetrical movements of the two hands take place Drinkwater (3) says that this is the natural condition in infancy and that dissociation occurs as a matter of gradual development. Pfeifer (10), in reporting on cases of paralytics, found that the greater the extent of paralysis on the right side the easier it was to teach the patient to write with the left hand, his interpretation being that the relative incapacity of the left hand results not from a native incapacity of this hand, but is a consequence of the inhibitions operating from the habitual use of the right hand With paralysis on the right side, such inhibitions are removed Patients with amputation of the right arm show quite different results in learning to write with the left hand Pfeifer apparently believes

that, with the removal of cortical inhibitions, the non-preferred hand can function with facility. This suggests a somewhat novel view as to what may be involved in dominant handedness Its significance relative to bimanual activities is obscure Common experience teaches us, however, that symmetrical movements of the hands involve much less effort than identical or asymmetrical movements Again, centrifugal symmetrical movements are easier than centripetal symmetrical ones Some interesting observations might be made in this connection on learning the various combinations of movement involved in swinging Indian clubs, swinging the clubs from the wrist might prove especially enlightening

REFERENCES

1 BOWMAN, H The effect of practice on different dextrality types. *Amer J Psychol*, 1928, **40**, 117-120
2 DOWNEY, J. E Dextrality types and their implications *Amer J Psychol*, 1927, **38**, 317-367
3. DRINKWATER, H. The left-handed child *Brit Med J*, 1924, **1**, 1113
4 HAEFNER, R The educational significance of left-handedness. *Teach Coll Contrib Educ.*, 1929, **92**, 1-92
5 ———— The relation between hand and foot tendencies of children. *J Genet Psychol.*, 1930, **38**, 338-351
6 LUND, F H Physical asymmetries and disorientation. *Amer J Psychol*, 1930, **42**, 51-62
7 MEYER, M F Psychology of the other one. Columbia, Mo. Missouri Book Co, 1921 Pp. 439
8 OATES, D W Left-handedness in relation to speech defects, intelligence and achievement *Forum Educ.*, 1929, **7**, 91-105.
9 OJEMANN, R H. Testing bimanual handedness. *J Educ Psychol*, 1930, **21**, 695-702.
10 PFEIFER, R A. Die rechte Hemisphare und das Handeln. *Zsch f d ges. Neur. u Psychiat.*, 1922, **77**, 471-508
11 RIFE, J M Types of dextrality *Psychol. Rev*, 1922, **29**, 474-480.
12 SCHAEFFER, — Spiral movements in man *J Morph & Physiol*, 1928, **45**, No. 1
13. SMITH, J. M Which hand is the eye of the blind? *Genet Psychol. Monog*, 1929, **5**, 213-252

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BIRTHPLACE AND OCCUPATION OF FATHER AS FACTORS IN NERVOUS HABITS IN CHILDREN

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The writer has presented in some detail in a previous study (2) a method for measuring the occurrence of nervous habits in children and an analysis of the incidence of such habits. The purpose of the present report is to record hitherto unpublished data for the same population on the relation of nervous habits in children to the occupation and place of birth of the father

Measures of oral habits[1] were collected for 635 white children in Grades 1 through 8 by a technique involving 20 repeated observations of constant length. It was assumed, and some substantiating evidence given, that measures of oral habits carried some validity as criteria of nervous habits in general The present analysis was made on the assumption that the records might have sufficient validity to show average trends, even though the measures would be considered inadequate for generalization in individual prediction Data on the occupation and place of birth of the father, based on information supplied by parents, were taken directly from the Pupil's Permanent Record Card The present report thus suffers from some of the defects inherent in research based upon incidental data A more adequate measure of ancestral origin, for example, could have been obtained by securing the birthplace of both the father and the mother and, in addition, that of the four grandparents All children whose parents were born in the United States were grouped under "United States," although a study of the names, immigration dates, and nationality reports show that many of the grandparents were born in the countries that have been studied separately It was believed inadvisable to take the "nationality" reports as a basis for study because of the varying interpretations placed upon the term by different respondents

The effect of using only the birthplace of the father in classification is to minimize any differences which may be present among children of varying ancestral groups Similarly, in the classification of occupations, difficulties were encountered because the school records did not designate specifically enough the work that was being done In spite of the weaknesses cited, however, it was believed that the availability of the data justified their use in an exploratory study

BIRTHPLACE OF FATHER

The records for the 635 children were first divided into groups according to the birthplace of the father It appeared that the United States, Sweden, Norway, and Germany had a sufficient number of representatives

[1]Oral habits were defined to include thumb-sucking, finger-sucking, nail-biting, and protruding tongue

TABLE 1

ORAL HABITS IN CHILDREN AND BIRTHPLACE OF FATHER

	Miscellaneous			United States			Birthplace of father: Sweden			Norway			Germany			Totals		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD.*	*N*	*M*	*SD*
Grades 1-6																		
Boys	40	10.4	4.7	122	9.5	4.6	32	10.3	4.7	24	8.0	3.9	8	6.8	4.6	226	9.5	4.7
Girls	47	12.9	3.4	122	12.4	4.2	42	9.7	4.1	16	10.7	4.7	13	9.7	4.8	240	11.7	4.3
Both	87	11.7	4.2	244	10.9	4.7	74	10.0	4.4	40	9.1	4.4	21	8.5	4.9	466	10.7	4.6
Grades 7-8																		
Boys	27	8.7	5.1	35	9.0	5.0	14	7.1	5.4	3	5.2	1.3	4	4.5	2.7	83	8.2	5.1
Girls	30	10.1	4.1	29	7.6	4.3	13	9.3	4.0	8	9.0	3.4	6	12.2	1.7	86	9.2	4.2
Both	57	9.4	4.6	74	7.7	3.9	27	8.2	4.9	11	8.0	3.4	10	9.1	4.3	169	8.7	4.7
All grades																		
Boys	67	9.7	4.9	157	9.4	4.7	46	9.3	5.1	27	7.7	3.8	12	6.0	4.2	309	9.2	4.8
Girls	77	11.8	3.9	151	11.5	4.6	55	9.6	4.1	24	10.2	4.4	19	10.4	4.2	326	11.1	4.4
Total	144	10.8	4.5	308	10.4	4.8	101	9.5	4.6	51	8.8	4.3	31	8.7	4.8	635	10.1	4.7

to warrant separate study All others, together with those for whom the information was lacking, were studied as a "miscellaneous" group Previous analyses had shown the presence of a sex difference and a difference in the records collected in Grades 1 to 6 and those collected in Grades 7 and 8. The grade difference appeared due to a difference in the conditions under which the data were collected rather than to an age change In order not to weight comparisons due to differences in the relative composition of the compared groups, the data were fractionated by sex and by Grades 1 to 6 and 7 to 8 The number, mean, and standard deviation of each group thus obtained, together with those for certain larger groupings, are given in Table 1 Ignoring the separate samples, the miscellaneous group, with a mean manifestation of oral habits of 10 8, would be placed at the top, followed by the United States with a mean of 10 4, Sweden with a mean of 9 5, Norway with a mean of 8 8, and Germany with a mean of 8 7. The consistency in the ranking of the birthplace groups in the various units of evidence offered is shown in a simplified fashion in Table 2.

The uniformity of ranks is particularly striking when the small number of cases determining some of the mean values is recalled Thus, the erratic position of seventh- and eighth-grade girls with German-born fathers is based on but 6 cases and that for those with fathers born in the United States on only 29 cases.

A more technical comparison of the obtained differences consists in an interpretation in relation to the size of the probable error of the difference Table 3 has been prepared by subtracting the mean of each group in the column at the left from the mean of the groups shown in the row at the top, calculating the probable error of the difference, and dividing the differences by its probable error The three minus signs show the only inversions in the 30 comparisons made.

How many of the differences should be interpreted as having been established with some degree of certainty? The answer lies in a definition in terms of probability The values for the differences divided by their prob-

TABLE 2
RANKING OF BIRTHPLACE GROUPS IN VARIOUS SAMPLES ACCORDING TO MEAN MANIFESTATION OF ORAL HABITS

Birthplace	Boys 1-6	Girls 1-6	Boys and girls 1-6	Boys 7-8	Girls 7-8	Boys and girls 7-8	Boys 1-8	Girls 1-8	Boys and girls 1-8
Miscellaneous	1	1	1	2	2	1	1	1	1
United States	3	2	2	1	5	5	2	2	2
Sweden	2	4 5	3	3	3	3	3	5	3
Norway	4	3	4	4	4	4	4	4	4
Germany	5	4 5	5	5	1	2	5	3	5

TABLE 3

Comparison of Differences Among Birthplace Groups

	$D—P.E._D$ Miscellaneous	United States	Sweden	Norway
United States				
Boys	0.6			
Girls	0.8			
Total	1.3			
Sweden				
Boys	0.6	0.2		
Girls	4.6	4.2		
Total	3.3	2.5		
Norway				
Boys	3.1	3.1	2.3	
Girls	2.4	2.0	—0.8	
Total	4.2	3.6	1.4	
Germany				
Boys	4.1	4.0	3.4	1.8
Girls	2.0	1.6	—1.1	—0.2
Total	3.3	2.8	1.2	0.1

able errors should hover about 0.0 if they were determined solely by chance. It appears that statistically significant trends are present in the data. The odds against the accidental occurrence of the median value in Table 3 are about 7 to 1. Eleven samples meet the criterion of $D—P.E._D$ equal to or greater than 3 (odds 22 to 1), and five samples the criterion of $D—P.E._D$ equal to or greater than 4 (odds 142 to 1).

The high ranking of the miscellaneous group appears to justify further inquiry into the reason for the position. We find that the largest subgroup is made up of persons for whom the information was omitted on the card. The other groups are represented by small and statistically insignificant numbers of French, Russian, Irish, English, Scotch, etc. Scrutiny of the data for the group for whom no information was given reveals an interesting fact. The mean manifestation is higher than that for the miscellaneous group of which they are a part and higher than that for any of the other groups studied. The 31 girls show a mean manifestation of 13.1 and a standard deviation of 3.2. The 24 boys show a mean manifestation of 9.8 and a standard deviation of 4.8, with a mean and standard deviation of 11.4 and 4.2 for the combined group. This difference is all the more interesting in view of the findings to be shown later which bring out the fact that the children for whom no paternal occupation was recorded show a higher incidence. A study of the children for whom no information was available on either birthplace or occupation of father reveals a mean manifestation of 11.3 for five boys and 13.5 for seven girls. Inaccessibility of the

children at the time the computations were performed prevented further inquiry into the composition of the group for whom paternal data were lacking.

The high manifestation of oral habits in children whose fathers were born in the United States may be due to the operation of obscure factors of selection. Available knowledge concerning the etiology of the behavior reported is too limited to warrant extensive speculation. The hypothesis has been stated frequently that the tempo and mode of American living tends toward the production of neurotic traits.

Paternal Occupation

The Barr-Taussig sixfold classification of occupations as used by Goodenough (1) was employed. Two additional groups were made, one for those children for whom no occupational data on parents was given, and one for those for whom the occupational data referred to the mother. The pertinent data for each group have been entered in Table 4, but the differences found appear too slight and inconsistent to justify detailed analysis.

A comparison of the largest mean score of 11.5 for the "no occupation" group with that for Group 3 shows a difference of 1.6 points. The difference has a probable error of .5 and the value for the ratio of the difference to its probable error becomes 3.1. The odds against the chance occurrence of such a difference are 26 to 1.

It must be concluded that significant occupational differences in nervous habits are not revealed by the criterion employed—oral habits. On the other hand, it appears that *absence of an occupation* in the school report of father's occupation carries with it a probability of a higher mean manifestation in the group of children concerned. Speculation concerning the reasons for the difference would carry the argument beyond the available evidence. One might be tempted to assume greater nervous instability in the non-employed group. It should be noted that at any given time the school

TABLE 4

Occupation of Father and Oral Habits in Children

Occupational group	Boys *N*	Boys *M*	Boys *S D*	Girls *N*	Girls *M*	Girls *S D*	Total *N*	Total *M*	Total *S D*
I. Professional	7	7.9	5.1	11	11.8	4.5	18	10.3	4.6
II. Managerial	9	7.9	4.9	10	11.3	3.5	19	9.8	4.6
III. Clerical	142	9.3	4.9	132	10.5	4.3	274	9.9	4.7
IV. Skilled labor	91	9.4	4.6	101	11.0	4.3	192	10.2	4.5
V. Semi-skilled labor	14	7.9	4.3	12	14.3	5.9	26	10.8	6.0
VI. Unskilled labor	19	7.6	4.9	31	11.2	4.0	50	9.9	4.7
No occupation given	19	10.2	4.4	21	12.5	4.3	40	11.5	4.5
Maternal occupation given	8	10.0	4.7	8	10.5	4.2	16	10.3	4.5
Total	309	9.2	4.8	326	11.1	4.4	635	10.1	4.7

records are likely to be less complete for transient residents of a district Consideration of psychogenic theory would lead to possible interpretations in terms of the child's need and striving for security In the absence of direct demonstration, it is perhaps unwise to infer reasons for the differences found

Summary and Conclusions

Using quantitative records of oral habits as a criterion of nervous habits, it has been shown that small but consistent trends are revealed among children according to the place of birth of the fathers. A combined analysis of 635 cases places a miscellaneous group at the top in mean manifestation followed in order by groups with fathers born in the United States, Sweden, Norway, and Germany

An analysis according to occupational classification does not yield significant differences. In the study of both birthplace and occupational groups the results suggest that absence of information on these questions in the *school file is related to a higher incidence of the habit*

In connection with this report, the applicability of the general method of measurement to the comparative study of races and cultures should be noted The method has been adapted to yield quantitative scores on a variety of overt behavior traits in formal and informal groups and is independent of language differences The field worker in anthropology should find in it elements of value as a means of collecting comparable data of demonstrable reliability

References

1. Goodenough, F L The Kuhlmann-Binet Tests for children of preschool age: *a critical study and evaluation* (*Instit. Child Welfare Monog Ser*, No. 2) Minneapolis Univ Minn Press, 1928 Pp viii+146
2. Olson, W. C The measurement of nervous habits in normal children (*Instit Child Welfare Monog Ser*, No 3) Minneapolis Univ Minn Press, 1929 Pp. xii+97

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THE VALIDITY OF INFANT INTELLIGENCE TESTS

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During the last six or seven years a number of investigators have published scales for measuring the mental development of infants during the first year of life The best known test of this type is Gesell's (5), but others have been published by Figurin and Denisova (4), Hetzer and Wolf (7), and Linfert and Hierholzer (8)

Such an interesting development naturally suggests the question whether *these scales can predict "intelligence" as that word is understood in con-*

nection with the standard intelligence scales which are used with older children An opportunity to answer this question was afforded the authors of the present study by the availability of the group of infants on whom the Lintert-Hierholzer scale was originally standardized and who had now reached an age at which the Stanford-Binet might be administered

The Linfert-Hierholzer scale contains tests for infants at one, two, four, six, nine, and twelve months In the course of the standardization 50 infants were tested at each of these ages In the present investigation it was decided to use as subjects the infants who had been used in standardizing the six-, nine-, and twelve month tests since lack of time made it impossible to test the entire group. As has already been stated, 50 infants were originally tested at each of these ages Since, however, some infants appeared in more than one of the groups, there were only 131 separate individuals in the three groups An effort was made to find and retest all these children In the case of 71 children this was done The remaining 60 children who could not be retested are accounted for as shown in Table 1.

The Linfert-Hierholzer scale was standardized during the academic year 1926-1927. The present investigation was carried on during the academic year 1930-1931. That is to say, the infants were retested about four years after the original test. At the time of the retest, the mean chronological age of the children was 4 years, 8 2 months, with a standard deviation of 2 1 months

For the retest the children were given the Stanford-Binet They were all tested in their own homes by one of us (J M). It was felt that the familiar home situation would put the child more at his ease and make it easier to establish *rapport* On the other hand, it must be admitted that

TABLE 1

Reasons for the Omission of Sixty Cases not Tested

Moved from town and could not locate	49
Insufficient data	8
Dead	2
Would not permit testing	1
Total	*60*

TABLE 2

Correlations between Linfert-Hierholzer Intelligence Quotients and Binet Intelligence Quotients

	No of cases	*r*
12 mo.	28	—20± 12
9 mo	26	—34± 11
6 mo	27	—11± 13
Total	81	00±.07

there were certain drawbacks to this arrangement Differences in the surroundings of the different homes might have influenced the results Some difficulty was experienced in persuading the mothers to refrain from prompting the child during the course of the examination These difficulties proved to be of only minor importance, however, and it was felt that they were not serious enough to invalidate any of the tests

Table 2 shows the correlation between Linfert-Hierholzer intelligence quotients and Stanford intelligence quotients for the three separate age-groups and for the entire group Since some of the infants appeared in more than one group, the 81 cases actually represent only 71 separate individuals

It will be noted that there is no significant relationship between the results of the tests administered during the first year of life and the retests four years later From this we are forced to conclude that the Linfert-Hierholzer scale cannot be used to predict intelligence as measured by the Stanford-Binet Since the other infant scales which have been published are very similar to the Linfert-Hierholzer in their general make-up, this investigation throws a certain doubt on them as well

As has just been said, the above results show that the Linfert-Hierholzer Scale will not predict Binet intelligence The reasons for this failure are, however, not so easy to discover There are several possible interpretations, as follows

1 The Linfert-Hierholzer Scale may itself be invalid or unreliable In the original standardization of this test a reliability of .81 was obtained at six months, 75 at nine months, and 88 at twelve months, but these results need to be confirmed Conger (3), working at the University of Minnesota, found rather low reliabilities for the test at one, two, and four months

2 The Binet test itself may be unreliable or invalid. It is well known that this scale is rather poor at the preschool levels. Its unreliability may therefore have helped to lower the correlations.

3 There is a possibility that Linfert-Hierholzer and Binet test different mental functions, the Linfert-Hierholzer revealing some sort of motor ability, while the Binet is largely a language test An attempt to test this hypothesis was made by administering several construction tests along with Stanford-Binet Since these tests were poorly standardized at preschool levels, it was felt that the results were not valuable enough to be correlated with Linfert-Hierholzer As far as this part of the investigation was carried, however, it gave the impression that Linfert-Hierholzer gave no better prediction of the results of motor tests four years later than it did in the case of Stanford-Binet

4 The IQ itself may not be constant Possibly the Linfert-Hierholzer gave a valid measure of the infant's intelligence during the first year and the Binet test did the same four years later; but the actual intelligence of the children varied during this interval This inconsistency might be due to

TABLE 3

CORRELATION OF CHAPMAN-SIMS RATINGS WITH NET CHANGE IN INTELLIGENCE QUOTIENT*

	No. of cases	r
12 mo	27	+ 43 ± 10
9 mo	26	+ 29 ± 12
6 mo	27	+ 36 ± 11
Total	80	+ 33 ± 07

*That is, the Chapman-Sims score of the infant's home at the time of the *first test correlated with the algebraic difference* (Binet IQ—L.-H IQ)

several factors. One possible explanation would be the influence of home environment When these infants were first tested Chapman-Sims ratings of their home conditions were obtained We correlated the gain or loss in terms of IQ points between the Linfert-Hierholzer test and the Binet test with the said Chapman-Sims ratings with the results shown in Table 3 From this we may infer that the low correlations between Linfert-Hierholzer intelligence quotients and Binet intelligence quotients are due, in part at least, to the influence of home environment which had not greatly affected the infants during their first year but which had exerted a significant differential effect on their intelligence when they were retested four years later.

CONCLUSIONS

1 The Linfert-Hierholzer Scale administered in the second six months of life does not predict Stanford-Binet score four years later

2 Since the Linfert-Hierholzer Scale is rather typical of the usual mental test for infants, some doubt is thrown on the validity of other tests in *this class as well*

3. Part of the discrepancy between Linfert-Hierholzer intelligence quotients in the first year of life and Stanford-Binet intelligence quotients in the fifth year of life may be accounted for by the differential effect of superior socio economic status which artificially raises the quotients of children from superior homes

REFERENCES

1 BAYLEY, N The consistency of mental growth during the first year. *Prog 38th Ann. Meet Amer. Psychol Asso., State Univ. Iowa, 1930,* 38-39.

2 BUHLER, C., & HETZER, H *Individual differences among children in the first two years of life* *Child Stud*, 1929, 1, 11-13

3. CONGER, J A An evaluation of the Linfert scale for measuring the mental development of infants Master's thesis, Univ Minn, 1930 *Pp 30.*

4 FIGURIN, N M, & DENISOVA, M P Short diagnostic outline of the child up to one year of age *Reflex & Neur. News*, 1926, **2**, 282-308

5 GESELL, A Infancy and human growth New York. Macmillan, 1928 Pp xvii+418

6 ———— *The mental growth of the preschool child, a psychological outline of normal development from birth to the sixth year, including a system of developmental diagnosis* New York Macmillan, 1925 Pp x+447

7 HETZER, H, & WOLF, K Babytests *Zsch f Psychol*, 1928, **107**, 62-104

8 LINFERT, H. E, & HIERHOLZER, H M A scale for measuring the mental development of infants during the first year of life (*Stud Psychol & Psychiat*, 1928, 1, No 4) Baltimore, Md Williams & Wilkins, 1928 Pp 33

9 MUEHLENBEIN, J M The validation of the Hierholzer scale. Master's thesis, Catholic Univ., Washington, D C Catholic Univ, 1931 Pp 25

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SCORES OF SPANISH-SPEAKING CHILDREN ON REPEATED TESTS

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Spanish-speaking children have been found to test consistently lower than English-speaking American children on standard tests. This lower standing is well illustrated by findings of Hughes (12) in Texas, of Garretson (6) in Arizona, of Delmet (3) in California, and of Sininger (21) in New Mexico

It is possible that the deficiencies noted by these and other investigators may be due to a number of factors, among which are (*a*) hereditary limitations, (*b*) inferior home environment, (*c*) language handicaps, (*d*) unsuitability of tests, and (*e*) lack of paralellism of conditions under which tests are given. These factors have been given consideration by various investigators working in the field of racial differences

The inferiority of the Negro and Indian races has been suggested by such students as Garth (7, 8, 9), Paschal and Sullivan (18), Hunter and Sommermier (13), and Pintner (19, 1923 ed, p 395)—a view not accepted by many investigators Yoder (30), in a review of studies of racial differences, concludes "that the concensus of competent scientific thought . . . finds no proof of racial inferiority or superiority and eliminates the usual methods of determining such standing from the field of scientific usefulness."

Assuming the inferiority of Indian heritage, a consideration of the history of New Mexico, where the present study was conducted, reveals that not only were the settlers of this region of good Spanish stock but that there

was a negligible amount of race mixture between Indian and Spaniard Records (11) of the expeditions and of the early settlements (1598-1700) point to this deduction, which is further substantiated by an insight into the practices, past and present, of the two races

The influence of environment upon under-privileged children has been illustrated by the work of Freeman and others (4) Delmet (3) and Tireman (27) suggest the existence of an environmental handicap among Spanish-speaking children, a view strengthened by a knowledge of the economic under-privilege found for these children in Texas by Manuel (13, pp 20-21)

While there are both extremes of socio-economic status in New Mexico, in general the home environment of these children must be classed as inferior The sparsity of population, coupled with the high degree of geographical and cultural isolation under which the colonists suffered for some three hundred years, is suggestive of the economic and cultural backwardness of the descendants of the early conquerors

The influence of isolation is manifested in the prevalence of sixteenth century customs and language usages Spanish is the home-language of the people, in spite of the efforts of the schools and even though the region has been under the control of the United States since 1848. This bilingualism offers room for study in its effects upon test results.

Studies by Murdoch and others (16) and by Goodenough (10) find little evidence of the handicap of bilingualism Yoshioka (31), on the other hand, found that bilingualism was a hardship for Japanese children in California Similar conclusions were arrived at by Smith (24) and by Saer (20) for Welsh children in Wales and by Wang (28) for Chinese in Ohio State University. Suggestion is made by Wright and Manuel (29) of a possible dual language handicap among Spanish-speaking students in Texas, while the work of Brown (2) and of Koch and Simmons (14) indicates the presence of language factors in tests that they used Otis (17) recognized that limitation in his test for he says that it cannot properly test children from foreign-language homes

The suitability of tests in establishing racial differences is denied by Gamio (5, pp 71-75) and questioned by Sunne (25) That the racial differences indicated by tests may be explained as differences of temperament rather than of intelligence is suggested by Hunter and Sommermier (13)

The importance of the conditions under which tests are given has been demonstrated by Thorndike (26) who, by repeating a test day after day, obtained substantial increases in results. Pintner (19, 1931 ed., pp. 92-95), though recognizing the influence of conditions and of coaching and training, believes that in the "usual school situation . . where group tests are not repeated day after day, we may conclude that the increases due to practice are negligible."

Thus it appears that, though the influence of conditions under which tests are given constitutes the basic problem of this study, inferior home environment and language limitations must be considered in interpreting the test results of Spanish-speaking children in New Mexico. It appears likely that inferior heredity does not enter into our testing program with these children. Whether, aside from questions of language, the tests are suitable in establishing racial differences is still an open question.

The particular variation in conditions forming the subject of this study consisted in giving both the Stanford Achievement Test (Primary and Advanced), Forms A, B, V, and V (in order named), and the Haggerty Intelligence Test (Delta 1 and Delta 2) to the same group of 45 Spanish-speaking children, Grades 3-8, in the Bernalillo County (New Mexico) Public Schools in December, 1928, April, 1929, November, 1929, and April, 1930.

TABLE 1

MEAN AGE SCORES (in Months)

	Dec., 1928	April, 1929	Nov., 1929	April, 1930
CA	141.2	145.2	152.2	157.2
MA	101.0	118.0	128.9	143.6
RA	109.5	120.2	126.4	134.4
ArA	116.6	124.5	128.1	135.7
EA	114.7	124.2	127.2	132.4

Table 1 shows that the average of the whole group increased in all abilities with each successive test. The greatest increase occurred between the first and second testings, while the period between the second and third testings shows the least increases. This latter period included three months of summer vacation.

Table 2 shows that, in general, the mean quotients are increasingly larger at successive applications of the tests, the greatest increases occurring in those abilities with the lowest quotients at the first testing. This indicates that the influence causing these changes was a unifying one that tended to improve the quotients. The gains are greatest between the first and second testings and least between the second and third.

A study of individual quotients revealed that, when the differences between the average quotients of each of the two school years were found for each pupil in every subject, on the average the quotients of 5% of the group remained constant, those of 62% improved, and those of 33% decreased. The average net gains for the entire group were: 1.29 points in ArQ, 1.18 points in EQ, 4.61 points in RQ, and 11.59 points in IQ.

Comparing the upper (6-7-8) grades with the lower (3-4-5) grades it is seen that at the beginning the means for the upper grades are higher than those for the lower grades but that changes at later testings are not pro-

TABLE 2
MEAN QUOTIENT SCORES

	N	Dec., 1928	April, 1929	Nov., 1929	April, 1930
IQ					
Grades 3-5	23	69.3	85.1	85.8	92.0
Grades 6-8	22	74.3	80.8	85.6	92.3
All	45	71.7	83.0	85.7	92.2
RQ					
Grades 3-5	23	76.2	81.3	82.3	87.2
Grades 6-8	22	79.8	85.4	85.4	86.1
All	45	77.9	83.3	83.8	86.6
ArQ					
Grades 3-5	23	80.9	83.1	85.3	88.9
Grades 6-8	22	85.1	86.4	84.6	86.0
All	45	82.9	84.7	85.0	87.5
EQ					
Grades 3-5	23	79.1	85.7	83.6	85.1
Grades 6-8	22	84.2	87.1	85.0	85.1
All	45	81.6	86.4	84.3	85.1

gressively higher for the upper grades. Lower-grade children equal and even surpass the means of the upper grades at various points and in several abilities, at times changing the relative positions of the two groups.

Comparison of individual quotients (first testing) by chronological ages revealed that there is no general tendency toward improvement in quotients as the ages increase. The average EQ (first testing) of the 23 children falling in ages of 142 months and below is 81.8, while that of the 22 children of ages over 142 months is 81.4. The average IQ of the 23 children of ages 142 months or less is 72.4, while that of the 22 children older than 142 months is 71. There are 12 of the 23 youngest children represented among the 23 children with the highest IQ's (first testing).

A similar age study of the trends in quotient changes between the two midyear points shows that, as the ages increase, there is a tendency towards less improvement in quotients. A study of the numerical results reveals the same thing. The 23 younger children made an average net gain of 2.02 points in EQ, while the older ones gained but .3 point. In the same way, the younger children made an average net gain of 12.0 points in IQ and the older ones 11.2 points.

The average IQ on the first testing of the 23 brightest children is 81.6, and that of the 22 duller children is 60.9. Even with these low IQ's, the average EQ of the brightest children is 87.7 and that of the 22 duller ones is 75.2. Some individuals with IQ's below 70 on the first test have subject quotients that approach the normal.

On the retests the brightest 23 make an average net gain in EQ of .3 point between the two midyear points, the duller gain 2.9 points. Simi-

TABLE 3

ZERO-ORDER r's BETWEEN QUOTIENTS AND BETWEEN CHANGES

Quotients	(1st test)	Changes (2 midyear points)
IQ and RQ	75	23
IQ and ArQ	54	04
IQ and EQ	72	07
RQ and ArQ	52	62

larly, the brightest 23 gain an average of 9 9 points in IQ, while the duller 22 gain an average of 12 4 points

Correlational studies, of which Table 3 is a sample, reveal marked positive correlations between all quotients of the first testing Reading and intelligence have the highest correlation of any two abilities, while reading correlates more highly with all abilities than does any other one ability The changes in the mid-points of the two years indicate close relationship between the changes in reading and those in intelligence, while reading again stands out in all correlations The average zero-order r between IQ's (first testing) and changes in RQ's, ArQ's, EQ's, and IQ's is —13, between ArQ's and the changes, —04, between EQ's and the changes, —10, and between RQ's and the changes it is —20

First-order partials, where the quotients (first testing) and the changes are held constant in the zero-order r's mentioned above, show that, in general, reading and intelligence, and their changes, exert the most influence upon the relationships noted—the effect produced by each in each case being about the same

CONCLUSIONS

1 As a general rule, the mean quotients in the various abilities tested are increasingly greater at successive applications of the tests The gain was greatest between the first and second testings and least between the second and third, the interval which included the summer vacation. The amount of change between the mid-points of two successive school years resulted in average net gains of from 1.18 to 11 59 points for the group as a whole

2. The increases in mental ability were the largest, with the increases in reading ability next in order

3 The upper grades show higher quotients on the first testing but make smaller gains on the retests than do the lower grades While there is little or no correlation between chronological age and ability as measured by the first tests, the younger children make greater gains on the retests than do older children

4 The brightest children have the highest educational quotients on the

first test, but on the retests the duller children make greater gains in both mental and educational ability.

5. Though marked correlation is shown between all abilities (first testing), reading, as a rule, correlates most highly with other abilities. Reading and intelligence have the highest correlation of any two abilities and, in partial correlations, exert the most influence upon the correlations between all other abilities (the effect produced by each in each case being about the same).

6 Quotients show negative correlations with their changes Changes in reading and in intelligence stand out not only in the zero-order correlations but also in partial correlations

Interpretations

Which of the four applications of these tests probably best represents the actual ability of these children? With regard to intelligence tests, Slocombe (*22*, *23*) believes the second test to be the best. This belief is based upon the conviction that tests beyond the first will be equally subject to the influence of "group factors" Whether this is true of the individuals in our group, our data do not show.

The present study does show that, for both mental and educational abilities of Spanish-speaking children, the changes beyond the second test vary not only for grade groups but also for different ages, for different school subjects, *and for the brighter and duller ones of the group* This variation makes any evaluation of the merits of any one application extremely difficult

At least one may say that it is advisable to defer judgment of the ability of these children until several tests, at considerable intervals apart, are given This is illustrated by the fact that the factors making for improvement showed a unifying influence upon quotients, causing quotients initially *at substantial distances apart, to approach each other more closely upon* each retest It is probable that some test beyond the first, given much later, will yield a truer measure for these children than can be obtained from the first test.

What are the possible causes of the large gains noted upon successive applications of tests? Possible causative factors suggest themselves in selection, in a lack of paralellism of conditions among the several testing points, in school training sufficient to accelerate pupils beyond their normal rate of growth, and in increasing facility with the English language.

Selection of the more gifted children for the retests did not enter into this program as only the results of the children who took all tests have been included. *Certainly, little* if any of the general superiority of the upper-grade children can be attributed to the gradual process of selection of the more gifted children as they advance in the grades When the more gifted half of the group is analyzed, it is found that 44% of it is composed

of lower-grade children, that there is no correlation between age and ability, and that more of the younger children than of the older ones are in the *upper half*

The physical conditions of all testings were equalized as far as was possible The same examiner was in charge of all tests, the same room was used, the time of day was approximately the same, mental and educational tests were given first equally often, all papers were scored at least twice, and the chronological ages were carefully investigated

The direct practice effect resulting from the repeated application of the same test (three forms of the Stanford, one form of the Haggerty) was probably a contributing factor in bringing about the gains noted The long intervals between testings (4 to 7 months) suggests that the direct practice effects in our program are probably relatively small It is also noteworthy that the amount of increase, even after such long intervals, exceeded that attributed to practice in cases where tests are repeated day after day.

Intensive school training, sufficient to accelerate pupils beyond their normal growth, could account for improvement in a limited field of ability The results presented here, however, show a general improvement over the entire range of abilities, over a period of two school years, and with children of all grades and ages No emphasis was placed upon any aspect of the curriculum during the two years of the testing program with the possible exception of the stress upon language (reading) incidental to the education of the pupils with a foreign home-language

The influence of the superiority of school environment over the home environment of these children is not easily overestimated Barrett and Koch (1) have shown that nursery-school training improves the test results of dependent children, which makes it seem quite possible that school experience is an important factor in producing improvements in the abilities (or in revealing native abilities) of children of inferior environment. That this factor was operative in the present instance is argued by the fact that the factors causing the changing in abilities affected the test results of these children with lessening intensity as the children grew older In other words, it appears that these children are more susceptible to the influence of these factors when the children first come into contact with school experiences (when they are young) than when they are somewhat more advanced in school work (when they are older)

Closely connected with the influence of school training is the influence of an increasing facility in the use of the English language This is well illustrated by the close relationship existing between ability in reading and all other abilities, and especially by that existing between reading and mental ability as measured by a standard group test Not only did reading correlate most highly with all abilities but it was observed that the improvement in reading was the one most closely associated with improve-

ment in all abilities, that reading was the ability most closely related to improvement in all abilities, and that the influence of reading ability and of the changes in that ability was the greatest of all in the correlations between the abilities, the abilities and their changes, and between the changes *themselves*

The close relationship between reading and other abilities is indicative of the influence of the language factors in the interpretation of test results This relationship suggests a criterion for the better judgment of the educational and mental abilities of Spanish-speaking children when the processes involved in the tests are less common to these children than they were to the children upon whom the norms are based

As a *final summary, the results observed in this study point to* certain influences which must be considered in interpreting the test results of Spanish-speaking children To avoid falling into serious error, investigators must take into consideration the conditions under which tests are given, for not only do successive testings at wide intervals apart, reveal that significant gains occur in the ability quotients of these children, but the improvement varies by grades, by ages, and by relative brightness of the children The relation of language ability (as measured by reading tests) to both mental and educational tests offers further room for variations in the interpretation of test results Failure to consider these factors may seriously impair the value of tests, even to the extent of invalidating results

References

1. Barrett, H. E, & Koch, H. L. Nursery-school training and test performance. *J Genet. Psychol*, 1930, **37**, 102-122
2. Brown, G L Intelligence as related to nationality *J Educ Res*, 1922, **5**, 324-327.
3. Delmet, D T. A study of the mental and scholastic abilities of Mexican children in the elementary school *J Juv. Res*, 1930, **14**, 267-279.
4. Freeman, F. N, *et al.* The influence of environment on intelligence, school achievement, and conduct of foster children *27th Yrbk Nat Soc Stud. Educ.*, 1928, 103-217
5. Gamio, M. Mexican immigration to the United States *1930.*
6. Garretson, O K. Study of the causes of retardation among Mexican children *J Educ Psychol.*, 1928, **19**, 31-40
7. Garth, T R The results of some tests on full and mixed blood Indians *J Appl Psychol*, 1921, **5**, 359-372
8. ——— A comparison of mental abilities of mixed and full blood Indians on the basis of education *Psychol Rev*, 1922, **29**, 221-236.
9. ——— A review of racial psychology *Psychol Bull*, 1925, **22**, 343-364.
10. Goodenough, F. L Racial differences in the intelligence of school children. *J Exper. Psychol*, 1926, **9**, 388-397
11. Hackett, C. W Historical documents relating to New Mexico.

12. HUGHES, L S A comparative study of the intelligence of Mexican children M.A. thesis, Univ Texas, 1928

13. HUNTER, W S, & SOMMERMIER, E. The relation of degree of Indian blood to score on the Otis Intelligence Test *J Comp. Psychol*, 1922, **2**, 257-277

14 KOCH, H L, & SIMMONS, R A study of the test performance of American, Mexican, and Negro children. *Psychol Monog*, 1928, **35** Pp 116

15. MANUEL, H T The education of Mexican and Spanish-speaking children in Texas 1930.

16 MURDOCH, K, *et al* Relation between intelligence and the acquisition of English *27th Yrbk Nat. Soc Stud. Educ.*, 1928, 343-353

17 OTIS, A S Otis Classification Test, manual of directions Yonkers, N. Y World Book Co, 1923

18 PASCHAL, F C, & SULLIVAN, L. R Racial differences in the mental and physical development of Mexican children *Comp Psychol. Monog*, 1925, **3** Pp 76

19 PINTNER, R Intelligence testing methods and results New York: Holt, 1923. Pp vii+406 (New ed, 1931 Pp xii+555.)

20 SAER, D J The effect of bilingualism on intelligence. *Brit. J. Psychol*, 1923-1924, **14**, 25-38

21. SININGER, H New Mexico reading survey M.A thesis, Univ. N Mex, 1930

22 SLOCOMBE, C S The constancy of general intelligence *Brit J Psychol*, 1926, **17**, 93-110

23 ————. The influence of practice on mental tests *Monog Psychol Lab, Univ Coll.*, London, 1930

24. SMITH, F Bilingualism and mental development *Brit J Psychol*, 1922-1923, **13**, 271-282

25 SUNNE, D. Comparison of white and negro children on verbal and nonverbal tests. *School & Soc.*, 1924, **19**, 469-472

26 THORNDIKE, E L Practice effects on intelligence tests *J Exper. Psychol.*, 1922, **5**, 101-107

27. TIREMAN, L. S Reading in the elementary schools of New Mexico. *Elem School J*, 1929, **30**, 621-626.

28 WANG, S L A demonstration of the language difficulty involved in comparing racial groups by means of verbal intelligence tests *J Appl Psychol*, 1926, **10**, 102-106.

29. WRIGHT, C E, & MANUEL, H. T The language difficulty of Mexican children *J Genet Psychol*, 1929, **36**, 458-466.

30 YODER, D. Present status of the question of racial differences *J Educ Psychol*, 1928, **18**, 470

31. YOSHIOKA, J G A study of bilingualism *J Genet Psychol*, 1929, **36**, 473-479.

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VISUAL IMAGERY OF HIGH-SCHOOL PUPILS

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The writer has described (1) a battery of three tests in visual imagery In Test I there are 24 series of photographs, each series ranging from a picture of perfect clarity to one completely blurred. A different object or scene is used for each series. In Test III, 72 pairs of photographs are employed, each pair consisting of a perfectly clear picture and a blurred one of the same object. When using Test I, a subject is required to locate his image of the first (most distinct photograph) at a picture or between two pictures in the series. An arbitrary value 0, 1, 2, or 3, etc is given to each photograph and intermediate step in a series A different plan is adopted in Test III. The subject selects pairs in which the blurred photograph corresponds most closely with his visual image of the clear one. Values had been assigned previously to each blurred photograph in Test III by having each member of a group of 132 subjects *pretend* it was his visual image of its perfect mate and locate it on a six-step scale of clarity Test II requires the subject to rate on the same scale the visual image aroused by each of 45 words The reliability coefficients for Tests I, II and III are 92, 92, and 86, respectively For the composite of the three tests the estimated reliability coefficient is 96. These figures were obtained from first-year high-school pupils. Although it was shown that subjects, in using a rating scale in the estimation of visual imagery, are consistent in any tendency to exaggerate or minimize their estimate, there was evidence that this tendency operated but slightly in Test II, and not at all under the conditions of Tests I and III.

THE PROBLEM

A study was made of the influence of age, sex, IQ, and scholastic ability on scores on the writer's battery.

PROCEDURE

Influence of Age and Sex Tests I, II, and III were given to 134 high school pupils whose chronological ages were between 12 and 21 years The results are given in Table 1

It is obvious, without further statistical refinement, that there is no difference between the sexes in respect to scores on the battery Also, within the limits 12 to 21 years, there is no apparent correspondence between age and score

Influence of IQ In view of the absence of correspondence between chronological age and scores on the battery, one would not expect to find significant correlation between IQ and ability to evoke visual images. The coefficient of correlation between IQ, as obtained from the Otis S A. Test of Mental Ability (Higher Examination), and scores on the battery was found to be $+.03 \pm 10$ for 43 first-year high-school pupils.

TABLE 1

SCORES ON THE COMPOSITE OF TESTS I, II, AND III FOR HIGH-SCHOOL PUPILS OF DIFFERENT AGES

Age	Boys *N*	Boys Mean Scores	Girls *N*	Girls Mean Scores	Boys and girls *N*	Boys and girls Mean Scores
12—13.99	8	134	16	147	24	143
14—14.99	12	142	13	138	25	140
15—15.99	10	148	15	142	25	145
16—16.99	11	141	9	143	20	142
17—17.99	6	129	11	143	17	138
18—20.99	14	151	9	142	23	148
Total *S*'s and mean scores	61	143	73	142	134	143

TABLE 2

COEFFICIENTS OF CORRELATION BETWEEN SCORES ON THE COMPOSITE OF TESTS I, II, AND III AND TEACHERS' MARKS IN FIRST-YEAR HIGH-SCHOOL SUBJECTS

Subject	*N*	*r*
English	31	+.17±.12
British History	31	+.01±.12
Geography	31	+.03±.12
Latin	31	—.08±.12
French	31	+.06±.12
Algebra	31	—.19±.11
Agriculture	31	—.02±.12
Art	31	+.12±.12
Unweighted Mean mark	31	+.02±.12

Correspondence between Academic Achievement and Scores on the Composite of Tests I, II and III. Teachers' final marks in eight first-year high-school subjects were obtained for 31 pupils, none of whom was a repeater. The marks were based on term work and a final examination of the essay type. While the unreliability of the marks for a single subject is granted, the total for the eight may be considered a fairly valid index of a pupil's ability to master the academic course in question. The coefficients are reported in Table 2.

It is apparent that no significant relationship exists between ability to evoke visual images as measured by the writer's tests and ability in the above eight secondary-school first-year subjects.

CONCLUSIONS

Scores on the writer's tests of ability to evoke visual images are independent of (*a*) age, within the range 12-21 years, (*b*) sex, within the range

12-21 years, (c) IQ, and (d) ability in certain first-year secondary-school subjects

REFERENCE

1 BOWERS, H Studies in visual imagery *Amer J. Psychol*, 1931, **43**, 216-229.

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KNOX CUBE TEST AND DIGIT SPAN[1]

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Although digit span has been included in a number of tests of general intelligence, and has been found to correlate with scores on intelligence tests and with educational achievement (6, 4, 1, 3), the Knox Cube Test seems to be a test of specialized ability, "paying a premium to resourcefulness and ingenuity" (5), and "should not be used for the purpose of measuring what we call general intelligence" (7) However, since the most common expedient employed to facilitate performance is to give the numbers 1-2-3-4 to the blocks and to remember the series of taps by the numbers, one would suspect a relationship between excellence of performance on this test and digit span

A class of 36 children just completing the first grade was selected for investigation of this point. Number work had not been started, but all the children proved able to recognize digits by sight, so that it was possible to present digits visually as well as orally The tests were given individually, because of the age of the subjects They were repeated for reliability at the end of a week Criteria consisted of the Pintner-Cunningham Primary Mental Test, a five-step estimate of general ability obtained from the teacher, and the scores made on an objective reading test.

Auditory series were given in the usual manner, beginning with three digits and continuing until failure was encountered in three trials at a given level. The range of performance on both first and second tests was from three to seven digits, inclusive Visual series were presented by single inch-high gray digits, mounted on a 3x5-inch white card Length of exposure was timed to approximate the time consumed in giving verbal series, and response was oral. Subvocal repetition was rarely noted, although one subject volunteered the statement "I can remember the numbers better if I say them to myself before I say them to you" The visual span ranged on the first test from two to six, and on the second test from three to six digits, inclusive With both modes of presentation, one successful repetition at

[1]This problem was suggested by, and investigated under the direction of Dr Florence L Goodenough.

each level was scored as correct, omissions and transpositions were scored as failures.

The Knox Cube Test was modified (*a*) by using, instead of cubes, inch squares of gray paper mounted at half-inch intervals on white cardboard, thus eliminating the third dimension and making the material used in this test less dissimilar to that ordinarily employed in the schoolroom, and (*b*) by using five squares instead of four, so that a wider range of number concepts could be brought into play in simple series instead of increasing the difficulty and using only four concepts The card was placed before the child with the instructions, "Watch me," the squares were tapped with the unsharpened end of a pencil, which was then given to the child with the words, "Now you do it" In the first test the series uniformly began at the child's right, for the second they were simply reversed so as to begin at his left Some children showed a tendency to begin as before at the right, but in every case quick self-correction resulted, and there seemed to be no effect on the final score This test is referred to as the modified Knox Cube Test

This modified test presents difficulties of administration and scoring not encountered in the oral or visual presentation of digits. Table 1 gives the series used, the number of children passing each, and the score awarded Three of the series proved to be of approximately equal difficulty for the subjects, and Series *h* seemed less difficult than Series *g* which preceded it In scoring, Series *c*, *d*, and *e* were all given a score of 4 Before adopting this scoring method, the coefficient of correlation (product moment formula) between the first and second tests was obtained, using first one point for each series (1-9), and second the method outlined above The first coefficiency was 18, the second 32 There seemed to be enough difference in reliability to warrant the adoption of the method used, but it is unfortunate that the test did not prove more reliable

TABLE 1

SERIES USED, NUMBER OF CHILDREN PASSING EACH, AND SCORE, FOR THE MODIFIED KNOX TEST

Series	First test	No children passing	Score	Series	Second test	No children passing	Score
a	54321	36	2	*a*	12345	36	2
b	543212	34	3	*b*	123453	35	3
c	54312	19	4	*c*	12354	24	4
d	53124	20	4	*d*	13542	29	4
e	51423	15	4	*e*	15234	22	4
f	531421	5	5	*f*	135425	14	5
g	524132	2	7	*g*	142534	1	7
h	5432135	5	6	*h*	1234531	7	6

TABLE 2

CORRELATION OF MODIFIED KNOX CUBE TEST WITH DIGIT SPAN AND THE CRITERIA

	Chron age	Teach. est.	Read- ing	Pintner Cun.	Vis 2nd	Vis 1st	Aud 2nd	Aud 1st	Knox 2nd
Knox—first	—21	16	04	18	—	—18	—	—41	32
Knox—second	—	—	—	29	18	—	01	—	
Auditory—first	—05	.23	15	.08	—	49	74		
Auditory—second	—	—	—	08	67	—			
Visual—first	23	36	.40	19	84				
Visual—second	—	—	—	.19					
Pintner-Cunningham	13	32	07						
Reading test	.08	65							
Teacher's estimate	—.21								

*Dashes are used where the coefficients were not calculated.

Significant remarks or behavior on the part of the children were noted, but yielded little information as to the plan or imagery used to assist the performance. One or two counted the taps as they made them, while several were obviously guessing. There was no indication that in any case the squares were subvocally numbered, or that the test was consciously associated with the visual and auditory presentation of digits

Practice and fatigue were controlled by the ABBA method, the class being divided into six groups and given the tests in all possible combinations of order. There was some indication of transfer of training between auditory and visual series, especially on the first test The second position seemed to be most favorable on the first test, but there was no difference in score whether the test was given first, second, or third on the second test.

The coefficients of correlation between all the tests were calculated by the product moment formula, and are summarized in Table 2 It will be noted that the test-retest reliability for auditory digit span is .74, for visual span 84 The correlation between auditory and visual span is .49, somewhat higher than the 39 obtained by Hao (3). The relationship between auditory and visual span and the Knox Cube Test is —.41 and —18, respectively, for the first test, and .01 and .18 for the second test It appears, then, that excellence of performance on the Knox Cube Test, as modified in this study, is not positively correlated with high digit span

REFERENCES

1 CLARK, A S Correlation of auditory digit memory span with general intelligence *Psychol Clin*, 1924, **15**, 259-260

2 EASBY-GRAVE, C Tests and norms at the six-year-old performance level *Psychol Clin*, 1924, **15**, 261-300

3 HAO, Y T The memory span of 600 Chinese school children in San Francisco *School & Soc.*, 1924, **20**, 507-510

4 HUMPSTONE, H J Memory span tests *Psychol Clin*, 1919, **12**, 196-200

5 RACHOPSKY, L M. Speed of presentation and ease of recall in the Knox cube test *Psychol Bull*, 1918, **15**, 61-64

6 TERMAN, L M The measurement of intelligence Boston Houghton Mifflin, 1916

7 WORTHINGTON, M. R A study of some commonly used performance tests *J Appl Psychol*, 1926, **10**, 216-227

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NOTE ON AGE OF PARENT AND INTELLIGENCE OF OFFSPRING

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Steckel (4), reporting an investigation into the relationship between age of parent and intelligence of offspring, concludes that "children born of very young parents are less intelligent than children born of more mature parents Below the age of twenty-six to twenty-eight for mothers and thirty to thirty-two for fathers, the younger the parents the less favorable is the prognosis for the intelligence of the offspring" While several possible explanations are suggested, the author makes no attempt to discover the factors operating to produce the relationship existing in her data

The subjects involved in the above study represent a wide range of socio-economic status It is probable that parents of differing socio-economic (and intelligence) levels marry at different ages Therefore, in order to reveal any result of biological factors dependent upon parental age that might operate to influence intelligence in the offspring, it was decided to study data from a group highly homogeneous as to social and occupational level This homogeneity was maintained by including no data other than that secured from families in which the father was a professional man holding a college or university degree This is, it seems, a more homogeneous group than any one level on the Taussig scale The factor of race has not been so thoroughly controlled, the group being almost entirely

[1]From the Institute of Child Welfare and College of Education, University of Minnesota

TABLE 1

MATERNAL AGES AND IQ OF OFFSPRING*

Intelligence quotient of offspring	Maternal ages								
165		1				1			
160									
155		1	1	1					
150		1	1						
145			1	1			1	1	
140	1	1	4	4	1	2	1		
135	1	1	6	7	3	3	6		
130	1	2	9	10	4	5	2	2	
125		2	12	14	9	3	2	2	
120		6	17	17	13	8	1	2	1
115	1	10	10	21	14	10	4	4	1
110	1	11	14	15	16	6	5	2	
105	1	8	3	9	6	3	1		
100		1	9	6	4	3	1	2	
95		2	1	3	2	4	2		
Ages	18-20 9	21	24	27	30	33	36	39	42-44 9
N	6	47	88	108	72	48	26	15	2
M	125.0	118 8	122 1	120 9	118 4	120 0	122 8	120 8	120 0

$N = 412$

$M_x = 29\ 34$ $\qquad M_y = 120\ 05$

$\sigma_x = 4\ 86$ $\qquad \sigma_y = 12\ 25$

$r_{xy} = -0\ 009 \pm\ 033$

$\eta_{yx} = 0\ 128$

*The writer is indebted to Miss Charlotte Croon for checking the accuracy of all computations.

North European, but including a small number of Jewish families In no case were there language handicaps.

The data employed were drawn from the files of the University High School, University of Minnesota For several years every child entering University High School has been given a series of five group intelligence tests. The tests used were Army Alpha 8, Pressey Senior Classification, Haggerty Delta 2, Terman Group, Form A, and Miller's Mental Ability Test, Form A. Intelligence quotients were computed for each individual from the results of each test, and then equated according to the method proposed by Miller (3),[2] so that all recorded intelligence quotients may be considered for practical purposes equivalent to Stanford-Binet IQ's Of these five equated IQ's, the median has been taken as the best measure of the child's ability.

When parents apply for admission of their children to University High

[2]A table of values used may be found in an article by Kefauver (2)

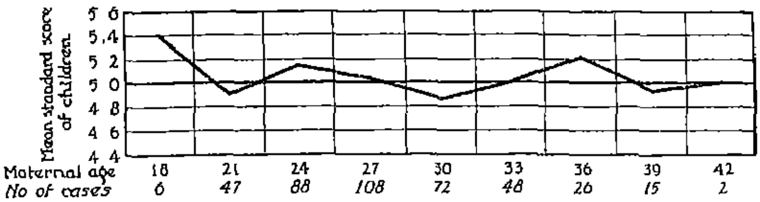

FIGURE 1

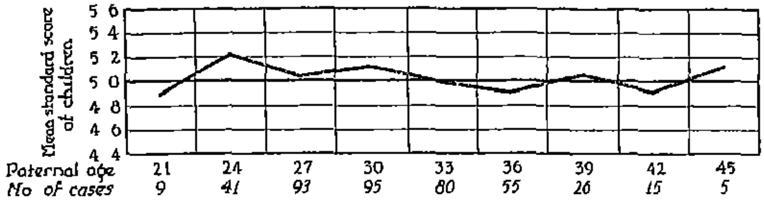

FIGURE 2

School, they furnish information as to their own ages, occupations, education, and certain other data As a check on the accuracy of these data, it was possible to compare in 25 cases two applications made by the same parents at different times In no instance was there an inconsistency in the statement of mother's age in the two reports, and in only one case did the age of a father as reported show any discrepancy. (This appeared to be a clerical error The case was not included in the data studied.)

The data consist of 412 cases with maternal ages, and 419 cases with paternal ages. The latter includes all except 9 of the cases of the former group.

The distribution of IQ's and maternal ages is shown in Table 1 For these data the product-moment correlation was found to be —0 009± 003 In spite of the small number of cases in certain columns, the correlation ratio (η_{yx}) was found to be 0 126, thus satisfying Blakeman's (1) criterion for linearity. (Blakeman's criterion = 1 92)

The distribution of IQ's and paternal ages is shown in Table 2 In this instance the value of r was computed as —0 0497± 033, and the value of η_{yx} as 0 097, again showing no evidence of any curvilinear relationship (Blakeman's criterion = 1 26)

Figures 1 and 2 present in another manner the nature of the relationship in the data studied Again it is clear that there is no tendency for the ages and IQ's to vary together

It will be of interest to compare these two figures with those included in Steckel's article. The comparison of the curves from these two sources suggests that selective factors related to socio-economic or occupational status are responsible for the apparent relationship in her data Since all

TABLE 2

Paternal Ages and IQ of Offspring

Intelligence quotient of offspring	Paternal ages								
165		1							
160									
155		1		1	1				
150		1		1					
145			2		1	1			
140	1	3	1	6	3	2		1	
135		1	9	5	6	3	1	1	
130		2	7	9	7	6	4		1
125		6	9	13	4	7	4	2	
120	2	7	17	10	18	4	2	3	2
115	2	4	18	18	8	11	9	3	1
110	3	9	14	17	14	9	4	2	1
105	1	3	8	11	8	1	1		
100		1	6	4	8	5		2	
95		2	2		2	6	1	1	
Ages	*21-23 9*	*24*	*27*	*30*	*33*	*36*	*39*	*42*	*45-47 9*
N	9	41	93	95	80	55	26	15	5
M	118 6	122 7	120.3	121 5	119.9	118 8	120 6	118 9	121 5

$N = 419$

$M_x = 32.58$ $\quad M_y = 120.0$

$\sigma_x = 5.04$ $\quad \sigma_y = 12.1$

$r_{xy} = -0.0497 \pm .033$

$\eta_{yx} = 0.097$

evidence of relationship disappears when these selective influences are held constant, it seems improbable that, within the age limits included above, there will be found any biological factor dependent upon parent's age that exercises an effect upon the intelligence of the child

It may also be noted that the age of the parent is directly related to order of birth within each family It might therefore be expected that if IQ increases with succeeding birth order, this increase would be revealed in higher IQ's at the later parental ages. No suggestion of any such increase can be seen in the above data.

References

1. Blakeman, J On tests for linearity of regression. *Biometrika*, 1906, **4**, 332-350
2. Kefauver, G N. Need of equating intelligence quotients obtained from group tests. *J. Educ Res.*, 1929, **19**, 92.
3. Miller, W. S The variation and significance of intelligence quotients obtained from group tests *J. Educ Psychol.*, 1924, **15**, 360
4. Steckel, M. L Parental age and intelligence of offspring *J Educ Psychol.*, 1931, **22**, 212.

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PSYCHOLOGICAL EXPEDITION TO CENTRAL ASIA*

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In July, 1931, the Uzbek Research Institute of Samarkand, together with the Moscow Institute of Experimental Psychology, organized the first expedition of the Soviet Union for the study of psychological characteristics of *peoples in various stages of cultural development*

The aim of the expedition was to investigate the variations in thought and other psychological processes of people living in a very primitive economic and social environment, and to record those changes which develop as a result of the introduction of higher and more complex forms of economic life, and raising of the general cultural level

One special task of the expedition was to develop new methods for evaluating intellectual status of individuals in very backward communities, because the usual methods of determining intelligence are inapplicable in the very special cultural conditions influencing the intellectual processes of the members of these groups Another task was preparation of educational *methods which could be applied to these communities*, such as the teaching of counting, reading, etc

The expedition was organized under the direction of Professor Alexander Luria of Moscow The members of the expedition included P I Leventuev, V N. Arbuzov, V V. Zaharova, H Ashrafi, A. Baiburova, L S. Gazaryanz, A D Kolbin, E N Mordkovich, H Hakimov, M Hodzinova, F N Shemyakin, A A. Usmanov, and R Yussupov

Before the expedition entered the territory, a two months' seminar was conducted by Professor Luria in Samarkand in May and June, 1931, in which special topics were assigned, methods studied, and preliminary projects were carried out

The expedition began its work in Uzbekistan with the native population The chief work was done in the Alai Mountain region, and in the districts (*Kishlaki*) *of Shahimardan, Yordan and adjacent uplands, where the people* live under primitive nomadic conditions. As a control territory was taken the region of the River Narin (Kishlak Utch-Kurgan) which has a very active cotton raising industry and highly developed collective farming, but with a population still backward culturally

Special attention was given to those socio-historical factors which influenced the development of the various stages of culture, and especially those changes which came as a result of the economic renascence of Central Asia

For the purposes of the research both territories were found to be very satisfactory The following problems were taken up by members of the staff

*Translated by J Kasanin and F L Wells

L S Sazaryanz and E N Mordkovich—the structure of perception in various stages of cultural development (perception of color, form, and optical illusions)

A R Luria, L. S Sazaryanz, E. N Mordkovich, and V V Zacharova—the configuration of vision in the system of visual thinking

A Baiburova and H Hakimov—structure of elementary intellectual processes in various stages of historico-psychological development

M Hodzinova—verbal logical configuration in the system of visual thinking

A D Kolbin—concept formation in stages of cultural development

P I Leventuev—the development of causal thinking

A D Kolbin and H Asharfi—traditional religious thought in the development of the personality.

F N. Shemyakin and P Yussupov—perception of printed material in a system of visual thinking.

A. A. Usmanov and V N Arbuzov—numerical operations in a system of visual thinking

A R Luria and V V Zacharova—self-analysis and evaluation of other individuals at various stages of personality development

All these studies will be published in the transactions of the expedition and some, subsequently, in foreign psychological journals.

The expedition is an attempt at collective experimental research by a group of psychologists undertaken for investigation of psychological origins in human development A similar expedition will be organized in the summer of 1932 to continue the same work. The expedition will have an international character, as it is planned to invite foreign psychologists to *participate in it*

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JEAN PIAGET *The Child's Conception of Physical Causality* (Trans by M Gabain) London Kegan Paul, New York Harcourt, Brace, 1930 Pp. viii+309.

In *The Child's Conception of Physical Causality*, Piaget continues the study of children's thinking which he has been publishing at intervals since 1926[1] The methods of study described in this latest contribution are on the whole the same as those employed in the earlier work, and there is a certain degree of overlapping with observations reported in *The Child's Conception of His World* The most important change in method is that the questions asked of the child are more frequently given a concrete setting than is the case in the earlier work For instance, he was asked about the effect of dropping a pebble into water with the objects for the experiment in front of him, and the experiment was performed before he was asked to account for the phenomenon Similarly, when he was asked to explain the working of a bicycle he had a real machine or a cardboard model to examine For the rest, the method consisted of oral questioning often of a very persistent kind The following is an example of such questioning, the subject being a child of three and a half years "How does a train go?—With wheels—What makes the wheels turn?—From the stuff (Fr *fabrique*)—What is the stuff?—Heat, smoke—Where does it come from, the heat that makes the wheels turn?—To the sky (=from the sky?)—Where does the heat of the engine come from?—In the tunnel, on the ground—Where does the heat of the tunnel come from?—It comes out of the tunnel It's heat, smoke—What makes the smoke? The funnel It comes out—Where does this smoke come from?—To the sky It goes through the holes in the station—Is there smoke in the sky?—Yes, over there (points to a cloud)—What is it? Heat—Are the clouds made of heat? Yes, of smoke—Where do the clouds come from?—From the heat—Where does

[1]*Language and Thought of the Child*, 1926, *Judgment and Reasoning of the Child*, 1927 *The Child's Conception of His World*, 1928

it come from? In the tunnel in the holes of the station—Where does it come from? Right up high."[2]

The book is divided into four sections The first section deals with the child's explanation of movement in relation to natural objects such as air, wind, water In the second section prediction and explanation were studied The third section deals with the child's understanding of the mechanism of bicycles, steam engines, motor cars, and aeroplanes The final section draws together and re-affirms Piaget's conclusions with regard to the characteristics of children's thinking about reality and causation

Before coming to the consideration of Piaget's views, it is of interest to take stock of the nature of his data Here are children from about four years to twelve years of age being asked questions for which, in the early stages anyway, they have not the knowledge for a correct answer What kind of answer will they hit upon? For the consideration of this problem we summarize below the answers to a representative selection of questions put by Piaget

The first two stages are the most interesting for the psychologist because they are but little affected by teaching on the subject-matters of the questionnaire When we look at the answers of the first stage as a group we see that they fall into two main divisions. When the child is asked about

Question	Answer 1st stage	2nd stage	3rd stage
(Hands are clapped) What did I do? Where does air come from?	Hands make air which comes from outside although windows are closed	Air from inside skin	Hands create
	These children, 1st and 2nd stages, do not realize that there is air in the room		
Lid with 1d in it is swung in a vertical direction. Why does not 1d drop out?	Box has sides	Penny has no time to drop	Box produces air and this flowing back keeps 1d in position
Where does wind come from?	Made by man, God, or machines	Made by objects (which as a matter of fact it moves.)	
What makes the clouds move along?	We make them move by walking	God or man makes them move and they can move of themselves because they are alive	They move by themselves

[2]Page 227.

Question	1st stage	Answer 2nd stage	3rd stage
Why does the water in the Arve move along?	People or fish make it go by their movements and it also goes of itself for the good of man	Stones, waves etc, are the occasion for making it do what it has in itself a tendency to do	Slope of bed plus finalistic and dynamic explanation
Why do clouds not fall?	Because they stick God keeps them up	The sky keeps them up	The wind pushes them
Why will water rise in vessel when 1d is dropped in?	The penny is heavy (He is really thinking of an upward thrust.)	Weight still assigned as reason, but prediction made in relation to volume	
Why is there a shadow here? (Hand held up against light?)	Because there is a hand from which shadow emanates and also because there are shadows under trees, etc	Emanates from object	
How does bicycle move along?	Any part that strikes the eye is named or the cyclist or air in tyres, etc.	As for 1, plus the idea of necessity of having cogwheels, chain, etc	Mechanical explanation attempted but not achieved.

things that are very difficult to observe or to experiment with he is likely to appeal to some very vague notion suggestive of power such as machines or God. The little child can have no real notion of why clouds do not fall If he is forced to guess he gives back one or other of the omnipotent causes that are so often quoted to him in answer to his questions about cause When he is asked about phenomena that are more within his ken, but for which he has not the necessary knowledge or experience for a correct answer, he picks out some striking feature and links it up with the effect as best he can For instance, when the hands are clapped it is obvious to him, as to others, that hands and air are the outstanding features, but he does not know that the room is full of air People always talk of going out of doors to get the air So if he is forced to give an explanation he makes the air transport itself through the closed windows to the hands

Again the sides of the lid are what strike the eye in relation to the penny not falling and for the greater part of the circular course they would be effective If we watch the clouds as we walk they appear to move People

rowing on the river seem to make the water move, so do fish swimming The way the penny sinks in the glass of water suggests weight, and, even if in the given experiment it is dropped very gently, the child will have had experience of things dropped into water causing an upward rush of air bubbles suggesting an upward force which to the child would account for the rise in the level of the water If you do not know that light is composed of rays that are blocked by most substances—and how should a little child know this?—what is there for you to hit upon as the cause of the shadow but the object? No doubt, it is strange that this black ghost should appear every now and then, but it does and it is just like the object that it accompanies It seems then that every one of these answers is the one to be expected, given the limited knowledge and experience of the child. Putting on one side the answers ascribing the action to God, the answer that the scientific adult would be least likely to give is the one to the hand-clapping question His grasp of scientific laws and the whole trend of modern physical explanations would make him loath to admit action over a gap in this way But the mass of non-scientific adults are very unclear with regard to continuity in fields, such as wireless reception, where their knowledge is limited. It is only a comparatively few years since even the scientist would have been prepared to admit the possibility of such action as the child assumes So why should the child have any prejudice against it?

Each second-stage answer involves an advance on the first in one or other of several different ways, e g ·

1. The feature in the situation picked out as the cause, while not actually such, is more nearly related to it than the factor chosen at the first stage In saying that the penny has not time to fall out of the lid the child is "warmer" than in saying that the sides keep it in because he has hit on the element of speed as essential—the sides may be there and the penny still fall if rotation is not fast enough

2. Action at a distance is ceasing to be assumed—the air comes from inside the skin of the hands instead of transporting itself magically from out of doors The shadow emanates from the object only, instead of being jointly caused by the hand and the shadow from under the trees

3 God or man are referred to as causes in the second stage in the case of only one question, "What makes the clouds move along?" The child has been forced to give up his original idea that we make the clouds move by walking (presumably from realizing some of the difficulties which accrue to such an idea) and, apart from explanations and teaching by adults, he has no way of knowing how they move He is cast back upon his omnipotent cause

In every case except that of the example last quoted the causes assigned at the second stage are more closely associated with the phenomena in time and space and more constantly associated with them than are the

causes assigned in the first stage. For example, the objects characteristically blown by the wind, such as trees, are more nearly related in time and space to the wind-blowing situation than is God or man. Stones, waves, and other objects of the river bed are more constant accompaniments of the river-flowing situation than are fish or people in boats. And so, as we *pass from the younger to the older children questioned*, we see the net, as it were, gradually closing in. From being some unseen power or some quite fortuitously present object the assigned cause comes to be something more and more nearly associated with the effect temporally and spatially.

Piaget's data suggests an enthralling drama of the human spirit wrestling with an almost overwhelming complexity of appearances and of memories, experimenting with them, trying to disentangle the sequences, being unconsciously affected by their different repetitions, shufflings, and re-shufflings, *sometimes succeeding through mere elimination of alternatives*. Out of this welter of activity Piaget crystallizes seventeen tendencies in the evolution of the concept of cause:

Characteristic of first period to about three years of age	1.	Motivation
	2	Finalism
	3	Phenomenism
	4	Participation
	5	Magic
	6	Moral causality (1 and 2 plus the element of *necessity*)
Characteristic of second period 3-7 or 8 years of age	7	Artificialism
	8	Animism
	9	Dynamism
Characteristic of third period 7 or 8 years to 12 and beyond	10	Reaction of surrounding medium
	11	Mechanical causation
	12	Generation
	13.	Substantial identification
	14	*Substantial identification involving rarefaction*
	15	Substantial identification involving condensation
	16	Spatial explanation
	17	Explanations by logical deduction

Piaget regards this evolution as characterized by three processes: the desubjectification of causality, the formation of series in time, the *progressive reversibility of the systems of cause and effect*. The changes in thought that account for the progress are:

1. The change from pure autism (lasting to the age of two or three years) to ego-centrism.
2. The change from ego-centrism (lasting to seven or eight years) to reciprocity and relativity.

It is against this theory of stages and of thought structures giving place

the one to the other that criticism has been directed in the past,[3] and in the light of Piaget's present data the criticism seems even more cogent than before. The whole of Piaget's writing gives the impression that he thinks of the world as immediately understandable by thought unless the latter is warped in some way Thus if the child has incorrect views, e g, thinks that the wind is alive, that the shadow is partly from under the trees and partly out of the object, that the penny does not drop out of the lid because it has not time, and so forth, it is because he is egocentric and his thought is syncretistic and transductive; it is not because he has had insufficient experience of the phenomena quoted to enable him to rule out these possibilities which, given his background of experience, are all perfectly good guesses Piaget would say that such guesses involve different thought structures from those involved in the thinking of a scientist similarly dealing with unfamiliar material and looking for the most likely answer to the question that he is posing.

In replying to criticisms of his theory, Piaget admits the importance of experience but insists that the thought structures involved will vary as a function of the experience He still hypothecates the thought structures that correspond for him to syncretism, transduction, and so forth—they are the faculties of thinking which come in to operate upon the material given by experience Piaget makes a complete cleavage between practical experience and the knowledge which comes from logical deduction. He admits that children know practically long before they can give a correct explanation of what they know—they can predict before they can explain This change from the stage at which they can predict correctly but not explain to the stage at which they can also explain he ascribes to the beginning of logical processes ". . there is complete continuity between the correct explanation and the logical processes *that have been set going by the discovery of the law*" (p 193) This last phrase gives the crux of the difficulty that the reviewer feels in relation to Piaget's theory—the logical processes are set going when the law has been discovered They have *not* been active throughout the process of discovery Piaget does not for a moment entertain the thought that the logic of the child's thinking, given his lack of knowledge at the early stages, is as good as his logic at the later Thinking, according to him, is only logical when its results agree with scientific facts

In line with this way of regarding the processes of thinking as something directed upon the material in the way of a faculty is his complete neglect of the child's striving after knowledge (2) Although he speaks of the mind's "laborious experiments," Piaget's treatment of his data suggests that for him they are museum specimens viewed from the standpoint of a

[3]See, for example, Isaacs (3) and Hazlitt (1).

pre-evolutionary scientist The child says this today because his thought is autistic, the other thing a year or two later because his thought is animistic, and so on There is no inkling of the experimenting and the successive approximations to truth in the progress from one view to another

Piaget's data will always be of value and of interest to the student of child psychology but it may be that the real importance of his work lies in the crystallization of points of view to which it has led Piaget has revived in one specific field of psychology the attitude of the Faculty Psychologists Other workers in the same field have been spurred on to justify their faith in a view more in harmony with the biological trends of the present day. The last word on either side is not likely to be said for many years to come, and, in the meantime, child psychology is profiting by the interest that has been aroused

REFERENCES

1 HAZLITT, V Children's thinking. *Brit J Psychol.*, 1930, 20, 351-361

2 ISAACS, N Children's 'why' questions Appendix to *The intellectual growth of young children,* by S Isaacs London Routledge, New York. Harcourt, Brace, 1930

3 ISAACS, S Intellectual growth in young children London Routledge; New York Harcourt, Brace, 1930 Pp. xii+370

4 PIAGET, J The language and thought of the child (Trans by M Warden) New York: Harcourt, Brace, London Kegan Paul, 1926 Pp. xxiii+426

5 ———— Judgment and reasoning in the child (Trans. by M Warden.) New York Harcourt, Brace, London Kegan Paul, 1928 Pp 257

6 ———— The child's conception of the world (Trans by J and A Tomlinson) New York Harcourt, Brace, London Kegan Paul, 1929. Pp ix+397

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RACHEL STUTSMAN *Mental Measurement of Preschool Children* Yonkers, N Y: World Book Co, 1931 Pp. x+368

Most of the interest in mental measurement, at least as exhibited by the research worker and examiner, has been focused upon children six years of age or older Investigators have tended to evade the difficult charge of rounding up representative subjects of preschool age and, not conspicuously less, the struggles necessary to engage the cooperation of these human mites who play such havoc with the examiner's vanity and express so unrestrainedly their affective tenors Miss Stutsman, however, like that rare group including Kuhlmann, Gesell, Foster, and Goodenough, has had the courage to shoulder the Sisyphean task of constructing a rather elaborate tool for measuring the mental development of young children

The volume under consideration is primarily a report of the methods she employed in building and standardizing the Merrill-Palmer Scale of Mental Tests as well as a guide for its administration, scoring, and interpretation Directions are also given for ordering observations on personality traits exhibited during the test The first section of the text, however, which contains not the least among its several distinctive contributions, is devoted to a brief characterization and evaluation of those instruments already extant which offer any direct aid in the solution of the problems of the mental measurement of preschool children The last section of the book provides a description of about 20 cases which illustrate the practical uses of mental *tests in the service of the very young* A valuable bibliography of 81 references concerning the mental measurement of children under school age rounds out the opus

The scale devised by Miss Stutsman is a point scale, consequently escaping many of the difficulties which characterize the age scale As a point scale, it is interesting in that it has a scoring scheme which provides for refusals and omissions Although the author, adopting an all-or-none method of scoring, has made no attempt to include tests at each level in the scale that are essentially similar, differing merely in complexity or difficulty, and prefers, instead, a variety of tasks empirically selected on the basis of the degree to which they differentiate between children of successive ages, *many of the tasks capable of being scored in terms of time do appear in* the scale at various levels with different time allotments as the basis for a rating of success The tests composing the scale are largely non-linguistic and are outstanding for their interest value They have been well described, also, subjectivity in scoring having been reduced to a minimum

Tables are provided which make possible the translation of scores into a mental-age phraseology and the interpretation of the former for monthly intervals in terms of sigma standing as well as percentile rank While the computation of an IQ on the basis of the scale is possible, this is discouraged

The statistical procedure employed by Miss Stutsman seems superior *The subjects used in the standardization of the scale, however, were not* very numerous—there were 631 in all with 49-81 for each age level—and were arbitrarily selected Hence the representativeness of the sampling may be questioned Actual standards, furthermore, were obtained merely for each six-month age interval from 18 to 78 months, the standards for intervening months being estimated by interpolation

The scale was validated by the comparison of its results with teachers' judgments, by correlating scores with chronological age and with Stanford-Binet mental ages, by noting the degree to which scores from various age groups overlapped, as well as by the success with which it differentiated between a normal and a small population of clearly feebleminded individuals With the Stanford-Binet Scale, *which is very poorly standardized for* the ages under five, the Merrill-Palmer Scale correlated 79

The author avoids the question of the nature of intelligence Her procedure in selecting her tests has been an eclectic and empirical one. In this, she would probably disappoint those who view intelligence as a unitary process and stress its expression in tasks involving education of relations At the same time, because of her multiple scoring scheme for certain form-board and picture-puzzle tests, her instrument may not meet the approval of those who place emphasis upon a wide variety of tasks While there are 93 items in the scale, there are only 38 different tests.

The general style of the work is clear, interesting, and unadorned The book, one of the World Book Company's Measurement and Adjustment Series, is well edited, adequately indexed, and effectively captioned

Miss Stutsman's contribution, to summarize, is primarily that of an instrument for evaluating the mental development of young children; but she should also receive credit for plugging up several of the larger gaps in the literature on mental testing

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C J. WARDEN. *Animal Motivation Experimental studies of the albino rat.* New York Columbia Univ Press, 1931 Pp xii+502 $5 00

Dr Warden, with the collaboration of several of his students, has brought together in this volume the published researches of his laboratory for the last six years All of these researches have contributed to the general problem of motivation in the rat and were made possible by a $5,000 grant from the Council for Research in the Social Sciences of Columbia University

In an introductory section the general technique is discussed The "Columbia obstruction method," as Dr Warden calls it, measures the strength of motivation in terms of the number of times an animal, in a given period, will cross an electric grid to reach a stimulus such as water, food, opposite sex, etc, of which he has been deprived for known intervals of time. Subsequent sections discuss experiments on hunger, thirst, sex, maternal, and exploratory drives In a final section, the relative potency of these drives is discussed It was found that the ranks for the female drives were as follows maternal, thirst, hunger, sex For the male rat they ranked as follows thirst, hunger, sex, exploratory When the data for both sexes were combined the relative ranking of the drives was as follows. maternal, thirst, hunger, sex, exploratory

The author is fully aware of the danger of conclusions concerning the motivation of the rat in general and is careful to state that "these conclusions apply only to the adult white rat, of the strain and age employed,

and reared unsegregated as to sex until approximately the standard test age" He feels, however, that the success of the research justifies its extension to other animal forms

This work is undoubtedly a valuable contribution to the field of comparative psychology and one can only wait with great interest the results of its extension to other forms than the rat

NORMAN L MUNN

University of Pittsburgh
Pittsburgh, Pennsylvania

BISHOP, F, & IRWIN, M Instructional tests in plane geometry, comprising thirty-six tests covering the various phases of the subject (with key and directions for scoring) (*Illustrated by H Schanck*) Yonkers, N Y, World Book Co., 1931 Student's booklet, $36, teacher's key $16

BRILL, A C, & YOUTZ, M P Your child and his parents New York & London Appleton, 1932 Pp xii+339. $2 00

COETZEE, J. C. Verstandsmeting (*Die Opvoedkundige Boekery*, ed by J. P Smuts & J G Meiring) Pretoria Van Schaik, 1931 Pp 224

COOK, W W. The measurement of general spelling ability involving controlled comparisons between techniques. *Univ Iowa Stud Stud Educ.*, 1932, 6, No. 6 (N S, No 221) Pp 112 $1 00

DAWSON, S, & CONN, J C M. Intelligence and disease (*Spec. Rep Privy Coun., Med. Res. Coun*, No. 162.) London H. M Stationery Office, 1931. Pp. 53

DOUGLASS, H R. The relation of high school preparation and certain other factors to academic success at the University of Oregon. *Univ Ore Publ.*, 1931, 3, No 1 (*Educ. Ser*) Pp 61

FARGUES, M La rédaction chez les petits Seine-et-Oise Juvissy, 1931 Pp 168

FELLOWS, J E The influence of theme-reading and theme-correction on eliminating technical errors in the written compositions of ninth grade pupils *Univ. Iowa Stud. Stud. Educ*, 1932, 7, No. 1 (N. S, No 222) Pp 56

GATES, A I., *et al* The modern school achievement tests New York Bur Publ., Teach Coll, Columbia Univ, 1931 Pp 32

GOODENOUGH, F. L. Anger in young children (*Univ Minn, Instit. Child Welfare, Monog Ser*, No. 9) Minneapolis Minn Univ Minn Press. 1931. Pp xiv+278 $2 50

HAMILTON, J. A. Englisch-Deutsch fur Psychologie. Frankfurt Gaul & Bentelmann, 1931. Pp 103. Paper, $1 00, boards, $1 25

HANSEN, R. Report cards for kindergarten and elementary grades (*Leaflet*, No 41) *Washington Govt Print. Office, 1931.* Pp iv+24. $10

ISAACS, S. The children we teach: seven to eleven years London Univ London Press, 1932 Pp. 176 3/6d

JONES, H E, CONRAD, H S, & BLANCHARD, M B Environmental handicap in mental test performance *Univ Calif. Publ Psychol*, 1932, 5, 63-99

KARPF, M. J The scientific basis of social work. New York Columbia Univ Press, 1931 Pp xx+424 $3.75.

KAWIN, E., & HOLFER, C. A comparative study of a nursery-school versus a non-nursery-school group. Chicago: Univ. Chicago Press, 1931. Pp. x+52. $.75.

KRANEFELDT, W. M. Secret ways of the mind: a survey of the psychological principles of Freud, Adler, and Jung. (Trans. by R. M. Eaton, with an introduction by C. G. Jung.) New York: Holt, 1932. Pp. xi+188. Library ed., $2.00, student's ed., $1.60.

LUMLEY, F. H. An investigation of the responses made in learning a multiple choice maze. *Psychol. Monog.*, 1931, 42, No. 189. Pp. 61.

MCLAUGHLIN, SISTER M. A. The genesis and constancy of ascendance and submission as personality traits. *Univ. Iowa Stud.: Stud. Educ.*, 1931, 6, No. 5 (N. S., No. 216). Pp. 95.

MINARD, R. D. Race attitudes of Iowa children. *Univ. Iowa Stud.: Stud. Char.*, 1931, 4, No. 2 (N. S., No. 127). Pp. 101.

MONROE, W. S., ENGELHART, M. D. A critical summary of research relating to the teaching of arithmetic. *Univ. Ill. Bull.*, 1931, 29, No. 5. Pp. 115. $.50.

MOORE, E. S. The development of mental health in a group of young children: an analysis of factors in purposeful activity. *Univ. Iowa: Stud. Child Welfare*, 1931, 4, No. 6 (N. S., No. 207). Pp. 128. Paper, $1.15, cloth, $1.50.

NEUMANN, H. Lives in the making. New York & London: Appleton, 1932. Pp. xvi+370. $2.25.

NISSEN, H. W. A field study of the chimpanzee: observations of chimpanzee behavior and environment in Western French Guinea. *Comp. Psychol. Monog.*, 1931, 8, No. 1 (Ser. No. 36). Pp. vi+122.

PRATT, C. C. The meaning of music: a study in psychological aesthetics. New York & London: McGraw-Hill, 1931. Pp. viii+253. $2.00.

RAGSDALE, C. E. Modern psychologies and education. New York: Macmillan, 1932. Pp. xx+407. $2.25.

REYNOLDS, A. Certain state programs for the improvement of rural school instruction. (*Bull.*, No. 18.) Washington: Govt. Print. Office, 1931. Pp. vi+32. $.10.

ROSE, E. L. The establishment by rats of two contrary discrimination habits. *Univ. Calif. Publ. Psychol.*, 1931, 4, 335-345. $.25.

Annual report of the Board of Regents of the Smithsonian Institution, 1930. Washington: Govt. Print. Office, 1931. Pp. xii+650.

STRONG, E. K., JR. Change of interests with age. Stanford University, Calif.: Stanford Univ. Press, 1931. Pp. xx+234. $4.00.

TAYLOR, J. C. The reliability of quarterly marks in the seventh grade of junior high school, together with the value of certain standard tests in predicting them. *Johns Hopkins Univ. Stud. Educ.*, 1931, No. 17. Pp. x+54. $1.15.

WELLMAN, B. L., CASE, I. M., MENGERT, I. G., & BRADBURY, D. E. Speech sounds of young children. *Univ. Iowa Stud.: Stud. Child Welfare*, 1931, 5, No. 2 (N. S., No. 212). Pp. 82. Paper, $1.00, cloth, $1.35.

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BEHAVIOR AND MATERNAL CARE OF THE NEWBORN MONKEY (MACACA MULATTA—"M. RHESUS")*[1]

From the Laboratories of Comparative Psychobiology, Yale University, and the Carnegie Laboratory of Embryology

O. L. TINKLEPAUGH AND CARL G. HARTMAN

Knowledge of initial tendencies and drives, out of and upon which subsequent activities are created, are essential for a complete understanding of adult behavior. In the case of human behavior, studies beginning with the newborn have greatly increased within recent years. In the numerous child behavior clinics which have been established both environmental and hereditary influences have been and are being studied. At the same time there have developed widely divergent interpretations of infant behavior at the human level, ranging from the Freudian concept of innate sex expression to the stress placed by Watson and his followers upon experience and environmental factors. While the ontogenetic study of the problem of early infant behavior has been surging ahead, the phylogenetic approach, with its manifold possibilities, has received little attention. In the case of lower animals, the dissimilarity between the structure and behavior in them and that of man probably accounts for the little progress made in the study of their young. On the other hand, infra-human primates, who so closely resemble man both structurally and behaviorally, have only recently become the subjects of intensive behavioral study. But few of their young, heretofore, have been observed from the time of birth because of lack of knowledge concerning the fertile period in the cycle and the period of gestation in the mothers, with the resulting impossibility of predicting the time of delivery. Hartman (2, 3, 4, 5) has now

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[1]The writers acknowledge their indebtedness to Mr. Carl D. Clarke, Department of Art and Photography, University of Maryland Medical School, who made our cinematic records, and to Mr. Arthur Rever, recorder of animals at the Carnegie Laboratory of Embryology, who rendered valuable assistance throughout our studies of parturition and of the behavior of the young.

determined these factors for the Macaca mulatta monkey, and investigators are able to anticipate and observe both the delivery and initial behavior of the young of this species.

The data upon which this report is predicated were secured by the authors in the course of a joint study of parturition previously reported (9) and observations of early behavior of Macacus rhesus monkeys The studies were made at the Carnegie Laboratory of Embryology, Baltimore, in the spring of 1929, at which time eleven pregnant females reached term within a period of six weeks The observations made upon these subjects and their offspring have been supplemented by records of the birth and behavior of other babies at the Carnegie Laboratory and of one Macaca irus (M. cynomologus) baby at the Primate Laboratory, Yale University.

Prior to this study, Lashley and Watson (7) reported the behavior of a young monkey through the first five weeks of its life. The reactions of a monkey mother to her stillborn baby were described by Yerkes (12). Hartman (2) gave the first detailed description of parturition and the early behavior of the young M mulatta. Speigel (8) described the birth and some of the early behavior of Macaca irus babies All available reports dealing with the birth and early behavior of young apes in captivity up to 1929 have been collected by Yerkes and Yerkes (14) A particularly good description of the birth of a chimpanzee was given by Fox (1), and Miss White (11) described the early behavior and development of the same animal The sensori-motor development of a Macaca irus monkey was reported by Kuroda (6).

Methods of Observation

In this study the parturient mothers were kept together in a paddock on the fifth floor of the Carnegie Laboratory until within a few days of term When the physiological symptoms suggested early delivery, they were taken into the building and confined in an obstetrical cage wherein their behavior could be observed and recorded in detail by both still and cinematic photographs and written notes. Each was kept here under observation night and day until the parturition process was completed, the baby washed, and it and the mother had lain down for the customary post-parturitional sleep.

Description of the Newborn

The newborn baby monkey appears much more human than he does in later life. His fur is completely saturated with fetal fluids and clings close to his body so that it is hardly noticeable. This emphasizes the similarity between his structure and that of the human infant. Our baby subjects varied in weight from 220 grams for the prematurely born Macaca rhesus to 660 grams for a long-term, stillborn M. mulatta baby. The average weight of 22 viable babies was 453 grams, but babies of 340, 368, and 380 grams have survived. Within this wide range of weights there were corresponding differences in stature, though for the most part the monkey babies at birth were short, stocky creatures, a fact which was emphasized by their big heads and relatively short necks. After they had been licked by the mothers their fur became fluffy and extended, making them seem far larger and heavier set than they really were. The fur ranged from a light to a dark brown and followed the pattern of the adults except for the well-defined parting of the hair over the tops of their heads. Bare surfaces such as the hands, feet, ears and face were at first a reddish pink but slightly darker than the skin of the newborn human baby. The fingernails were short, clear, and of a lighter pink than the fingers. The eyes, which opened wide unless they had been injured during the process of delivery, and all of which were to become a deep brown, ranged at birth from a brownish blue to a brownish hazel. At birth the gums are tender and frequently distended by developing incisor teeth which commonly erupt during the second or third week, structural evidence of the monkey baby's relatively advanced physical condition as compared with the human infant. The common criterion of age in human beings, the wrinkles of the face, was entirely deceptive in the baby monkeys. Their deeply wrinkled faces suggested miniature Methuselahs, though these lines were largely to disappear within a few weeks.

Events Typically Accompanying Birth

The early reactions of the newborn monkey are determined in part by the behavior of the mother during and immediately following the baby's birth. We have elsewhere described parturitional behavior in detail (9), but let us here briefly recount those portions of it which typically occur after delivery of the baby begins. Our pregnant subjects were in labor for from 20 minutes to 34 hours

before their babies were delivered, though periods of three to four hours were most common. After delivery had progressed until the baby's head appeared at the entrance of the birth canal, the mother began to tug at it violently, apparently in an effort to remove it. By the combination of uterine and abdominal contractions and this manual assistance the baby was delivered and the mother drew it around to the front and up to her breast. For the next few minutes the mother's time was devoted to licking the fetal fluids from the baby, though at times she reached back to explore the genitalia from which the still attached umbilical cord extended to the baby. Finally, there were more abdominal contractions which expelled the afterbirth into the canal and from there it was drawn forth by the mother with her hands. She ignored the baby for the time being and, after licking this tissue, she consumed it down to its point of junction with the umbilical cord. The baby was licked a little more; the mother removed all traces of fluids from her own hands and from the floor of the cage. Then she walked to the water container and drank, the baby, either unaided or with the support of one of the mother's arms, clinging tightly under her.

The behavior we have just reported is primarily that of the mother. The activity of the baby monkey at birth can best be shown by describing some of the cases we observed.

Behavior of Babies During and Immediately Following Birth

During the time this study was under way the authors witnessed five births, and in six other cases the animals were discovered shortly after the time of delivery. Hartman previously witnessed one birth (2) and has since observed a number of others. Hartman (4) found the average gestation periods of monkeys in the Carnegie Laboratory to be 164.3 days. With this information and known copulation ages of the Carnegie Laboratory babies, we were able to judge their relative maturity at birth.

Following are accounts of the behavior of five of the monkey babies during and after birth, and of three babies shortly after delivery. These examples have been selected so as to include both premature and full-term babies, and two instances in which the mothers were primiparous.

Baby Nina, No. 72. Born April 16. Weight 550 grams. Copulation age 168 days. Mother, multiparous female, No. 49.

9.50 P M. The head of the baby appears and the mother reaches back, explores it with her hands, and then draws it forward, round her left side and up to her breast The baby moves as it is being delivered The eyes, at first mere slits, open and close and the mouth moves. As the baby is being drawn forward by the mother, it reaches out with its hands, touches the floor of the cage, and then grasps one of its hands with the other. Finally, with a quick movement, it embraces the arm of its mother and clings tightly as she draws it around before her *9 53* P M As the mother licks the baby, holding it up and turning it first one way and then another, the infant reaches out wildly with its hands and feet for something to grasp At times it seizes hold of its own hands or arms, or again, of its own head It cries frequently When its face is in contact with the mother it constantly mouths through her fur The mother's fur gets into its mouth and nose and it chokes or sneezes *10 07* P.M Afterbirth delivered, mother spends 25 minutes licking and consuming it Baby during this time clings to her breast with hands and feet, sometimes partially supported by one of her arms. *10 26* P M.· Baby coughs sharply and then jerks its body incoordinately as though in a rage. *10 36* P M . Mother lies down, first on one side and then on the other, with baby at her breast, but not nursing *10 55* P M.. Mother rests in sitting position with her head drooped over the clinging baby. Baby's head droops also, and it seems to be sleeping for the first time *11 15* P M . The baby, held on the floor by the mother, raises body on its four legs and holds head out straight. The mother turns it over on its back and begins picking through its fur. The baby struggles vigorously to right itself and finally succeeds, again raising itself on all fours Though able to support its own weight in this manner, its arms and legs tremble under the strain. *11 20* P M The baby entirely cleaned, the mother now begins to treat it as other than an object which is merely to be licked She looks at it and embraces it. She looks from the baby to the observers and makes a smacking sound with her lips, after which she cuddles the baby closer to her and looks down at it, while she smacks and makes low gutteral sounds

Baby Lou ("L"). Born May 12 Weight at birth 420 grams Copulation age 171-189 days Mother multiparous female, No 7

No. 7 was placed in the obstetrical cage for observation with her yearling son, George, who had never been separated from her.

8 10 P.M · Head of baby appears and it begins crying as mother

reaches back and tugs at it. *8 12* P.M Before baby is entirely delivered it seizes the fur of its mother's legs with its hands. Mother begins licking head before it is fully delivered and then draws the baby up to her breast *8.15* P M . The baby's eyes are open, and it moves its arms as the mother licks it *8·16* P M Placenta delivered and mother turns to licking and consuming it. Baby clings to her breast where it nuzzles through her fur with its mouth *8·21* P.M.: George, excited through the series of events, goes up and feels the face of the baby *8 24* P.M . Mother lies down, alternately licks her hands and the baby and then rests. *8 42* P M. Mother still lying down with baby at her breast *8 45* P M The mother, very ill, rolls about the cage in distress, ignoring baby The baby is still very wet, having been licked much less than is commonly the case *8 50* P M The baby, lying on the floor alone, tries to walk; sits up at mother's head. Baby cries and mother puts her arm over it *8·57* P.M The mother, still distressed, ignores the crying baby *9 00* P M.. George goes to the baby and lies on its head for about five seconds, leaves, and then returns and lies down beside it. *9:06* P M : Observers attempt to catch George to remove him. He cries out and mother comes to his rescue. George taken away, but he, mother, and baby all cry. *9 20* P M · George returned, mother embraces both him and the baby and they lie down together and rest. From time to time she licks herself and the baby *2.00* A M Mother and baby have slept most of the time. *4 18* A.M : Baby locates and begins to mouth the right nipple.

Baby No. 77. Born July 9 Weight at birth 450 grams Copulation age 165 days Mother, multiparous female, No 51.

First observed at *7 40* A.M about an hour after delivery, while baby was still wet Mother was walking around cage carrying the afterbirth in her hand and with the baby clinging to her breast. The mother was disturbed by the observers and, therefore, the early observations were of little value *9.50* A.M : The baby has hold of the left nipple. It continually looks about and extends its hands as though reaching for something. *10 56* A M : The baby continues looking around and tries to get away from the mother *10 57* A M : The baby gets hold of the wall of the wire cage and hangs from it. *10 58* A M.: The baby again tries to escape from the mother but she quickly draws it back to her.

Baby No 73 Born April 9 Weight at birth 530 grams. Copulation age 167 days. Mother, multiparous female, No 2.

11 28 A.M · Face of fetus appears *11 33* A M Baby delivered with manual assistance of mother Chokes immediately; alternately opens and closes eyes and gives shrill, piping cries. Seizes hold of mother's fur and clings to her *11·37* A M. · Baby climbs up onto mother's neck where it bites down on her fur and her ear, chokes. Mother draws baby down to her breast *11·48* A M.: Baby yawns and jerks its body violently as though in temper tantrum. *11 50* A.M. · While consuming afterbirth, mother ignores baby who clings to her breast crying softly. *12 15* P M Baby, who from the first has clung to mother with hands and feet, at the same time constantly mouthing her fur, now finds nipple and bites down on it. *12·28* P.M Mother lies down with baby at her breast and rests. *12 30* P M. Baby yawns Left eye is now swollen as result of manual exploration by mother during delivery Baby and mother both yawn. Mother lies down again with baby at her breast and both sleep.

Baby Joshua ("J") Born April 8 Weight at birth 367 grams. Copulation age 155 days Mother, multiparous female, No. 34

The birth not witnessed, this baby is discovered at 11:00 A.M still wet and clinging to his mother's breast He maintains his position by holding to the fur on the mother's sides with both hands and feet She lends him additional support with one of her hands held just below his neck Baby appears weak and inactive, doubtless due to his premature birth He sleeps most of the time, seldom awakening even when the mother is moving about the cage. He coughs and yawns within a few minutes after discovery. During his waking moments he almost constantly works his mouth up and down through the mother's fur, although he does not discover the nipple during the first day The mother is nervous and pays little attention to him while observers are present, though she picks through his fur and examines his face, especially his eyes, when left alone

Baby No 75 Born May 15 Weight at birth 430 grams Copulation age 160 days Mother, primiparous female, No 39

1 48 A M : Head of baby appears *1·49* A M . Mother reaches back with both hands, seizes and draws head around to one side and forward, licking it as she does so Baby begins crying Washing process is continued *1 57* A.M · Baby, left to its own efforts, clings to mother's thigh, cries, and looks around *2 06* A M · Mother lays afterbirth down and licks the baby Baby looks around, yawns. *2,08* A M · Mother alternately eats afterbirth and licks baby. Baby

clings unassisted to the mother's side and persistently peers about. *2.45* A M The baby, in the course of its mouthing through the mother's fur, locates the right nipple and mouths it

Baby "M." Born May 14 Weight at birth 530 grams. Copulation age 180 days Mother, primiparous female, No 12.

4 12 P.M.. The baby's face appears and the mother explores it with her hands and then walks about the cage while the body is being expelled. Upon its first appearance, the baby's face is very blue and the baby seems lifeless Possibly due in part to the stimulation of the mother's repeated efforts to deliver it manually, and to the effect of having its half-expelled body dragged along the floor of the cage, it soon becomes active. It begins crying, blinking its eyes, and seizing the fur on its mother's legs before it is fully delivered *4 43* P M.: The baby is delivered and the mother draws it up before her and begins licking its head *4:47* P M.. As the washing process still continues, the baby seizes the mother's fur vigorously in its efforts to avoid being up-ended. *4 55-5 06* P.M: Mother devours placenta, leaving baby to cling, unaided for the most part, to her breast. *5 07-5 20* P M : The washing process is completed and the mother picks through the baby's fur while holding it on its back on the floor of the cage. *5 45* P M : The baby, clinging to its mother's breast, turns its head around and stares first in one direction and then in another *5 50* P M.. Baby yawns. *6 30* P.M : Baby mouths its own arms and stares at and reaches toward the floor of the cage

Baby born at Yale Primate Laboratory, June 14. Weight at birth 220 grams. Premature Mother, Psyche, a Macaca irus female (primiparous). Father, M. mulatta.

The baby was first discovered in the arms of the mother by the caretaker at 9 50 A.M. It was nearly dry and probably an hour old. The afterbirth remained unmutilated and attached to the cord The baby's left eye was swollen shut, evidence of the mother's assistance in delivery The day was exceedingly warm and dry, and both baby and mother appeared tired and weak The mother picked through the baby's fur and repeatedly opened and closed the swollen eye, at times gently extending her tongue to it The placenta was ignored by the mother and dangled on the end of the cord The baby slept most of the time when not disturbed by the mother's fur-picking activities. At 10 35 A M the baby yawned and sneezed.

The baby showed the same tendency to grasp objects with its hands, feet, and mouth that was demonstrated by the others, but due to its weakness was unable to support itself The result was that instead of maintaining the typical position with its ventral side toward the breast of the mother it hung limply over her supporting arm with its face away from her In this position, it generally grasped its own hands or arms or even held to its own head The mother made no effort to turn it about so that it faced her The maternal arm over which the baby hung generally extended across the baby's abdomen, but frequently when the mother moved from place to place or brought her other arm up for support, her wrist rested across the baby's throat causing it to choke At 10 46 A M the baby roused itself, yawned, peered about, and stared unblinkingly toward the blazing sun

The cinematic records and observations of the behavior of the eight babies we have just described, in addition to the other cases witnessed by Hartman, enable us to construct a general behavior pattern for newborn Macaca mulatta babies Differences occurred in the activities of the monkey infants, but for the most part, as we shall show, these were due to the physical development of each baby at the time of birth.

Activity on the part of the typical monkey baby begins as soon as it is sufficiently free from the birth canal to make any form of movement possible When the head appears, the eyes begin to blink and the baby gives shrill, piping sounds The arms reach out and seize hold of any object within reach as soon as they are expelled (Plate 1, Figure 1) At times it appears that this behavior actually aids in the process of delivery. Once a body is free, the mother draws it around before her and begins the cleaning process At *this time, the baby indulges in violent seizing reactions* with both hands and feet When it is upturned it struggles to right itself If held suspended in the air it grasps its own hands and feet, one in the other, or seizes its own body If left on the floor momentarily, as happened in two of our cases, it stands up and attempts to walk During, or soon after the cleaning process, the afterbirth is delivered and the mother's attention is directed away from the baby At this time the young monkey executes the behavior which is the most important from the standpoint of its survival The mother may hold the infant to her breast with one arm as she turns to this other activity She does not otherwise determine the baby's position

PLATE 1

Figure 1 During delivery baby clings to sides of mother

Figure 2 A few minutes after birth, Pola, unassisted, clings to the breast of her mother The umbilical cord and afterbirth are still attached

Figure 3 Three babies clinging to their mothers in typical positions with and without maternal assistance

Figure 4 The one-hour-old Nina stares toward the photographic lights

Figure 5 Negri threatens observers while her one-and-one-half-hour-old baby bites down upon the newly discovered nipple

relative to her, but *it orients itself* toward her in the ventro-ventral *relationship and clings tightly with both hands and feet* (Plate 1, Figure 2) While the baby is in this position its mouth, which has been constantly opening and closing, explores through the mother's fur and bites down upon any area or object which it can reach in this manner During the oral exploration the baby, quite by accident, it seems, comes in contact with the maternal nipple Once this relationship is established the newborn baby devotes most of its *waking hours clinging to the mother's breast with hands and feet* and to the nipple with its mouth (Plate 1, Figure 5) Commonly, during the first hours, or even for a day or two after birth, the contact with the nipple involved only mouthing and biting movements, behavior not uncommon with human babies when first given the breast Suckling seemed to appear at irregular times following birth, though we were unable to determine the exact time of its *beginning* This *indicated that the mouthing of the nipple* was a contact reaction brought about, in part at least, by the sensory stimuli starting from sense organs in the lips and possibly also the tender gums Hartman (1921), thus far the only person yet to observe the actual birth of a marsupial, states that the twelve-and-one-half-day-old embryo finds the nipple of the mother's pouch in much the same way as the baby monkey finds the nipple, namely, by successive *contacts of the muzzle by trial and error* The young marsupial, in both the pouched and the pouchless species, and also the young of certain rodents are carried about for some time on the nipples and may even be dragged in this way after attaining a considerable size In some species of bats the young are carried aloft clinging to the mother in search of winged food, while other species hang their babies up in the nursery from the time of birth In the monkey, as will be shown later, yearlings, even after weaning, when rushing frightened to their mothers' breasts may grasp the nipple and cling to it.

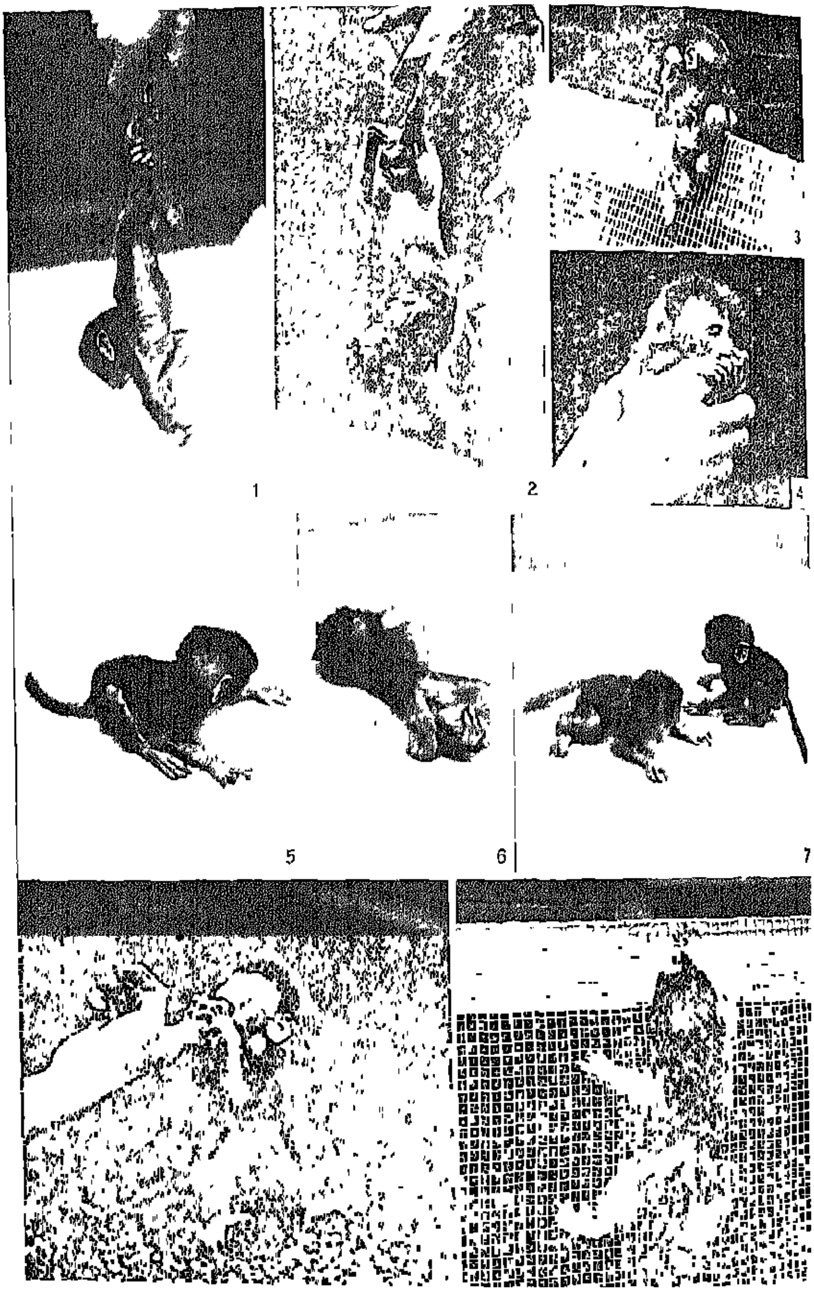
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PLATE 2

Figure 1 Premature Joshua, first day, supports self by one foot
Figure 2 Nina, third day, supports self and 18-day-old Joshua by one flexed arm
Figure 3 Pola, eighth day, at top of screen where she fled in fear
Figure 4 Joshua, third day, contented in experimenter's hands when able to seize them with his hands, feet, and mouth
Figure 5 Joshua, premature, starts to orient upwards on inclined plane when four days old
Figure 6 Nina's righting movements on third day are interfered with by her grasping reactions
Figure 7 Walking behavior of full-term baby Nina (left) on third day, and premature Joshua on eighteenth day
Figure 8 Pola, eighth day, is quiet while making manual, oral, and pedal contacts
Figure 9 Pola climbing upward when frightened on eighth day

We have briefly pointed out that the washing of the baby and the consumption of the afterbirth may well be the outgrowth of the mother's response when she first begins exploring the genital region manually, prior to delivery, and licks the fluid she has there encountered from her hands Just as these fluids are licked from her hands they are also licked from the baby The mother first reacts to the offspring as though it were little more than an object covered with these fluids She does not handle it roughly, but at the same time she shows no immediate evidence of fondness for it To be sure, she will cling tightly to it or even fight to prevent its being taken from her, but she will do likewise to retain the afterbirth before its consumption As soon as the afterbirth is delivered, the mother temporarily ignores the baby and turns to the consumption of this mass of tissue During this time the baby may climb upward and seize the hair of the mother's neck or head, thereby interfering with her other activity In that event the mother rather abruptly draws it back down to her breast or even lowers it in front of her abdomen where she restrains its activities by seizing one of its feet or its tail with one of her feet It is during this time that the baby usually comes in contact with the nipple in the manner we have described above

In the course of the baby's exploration of the mother's breast it coughs, chokes, or sneezes two or three times, apparently as a result of the mother's fur having entered its nose or throat On other occasions, however, the babies have been observed to sneeze after staring momentarily at a bright light While the baby is engaged in its initial exploration of the mother's breasts it may

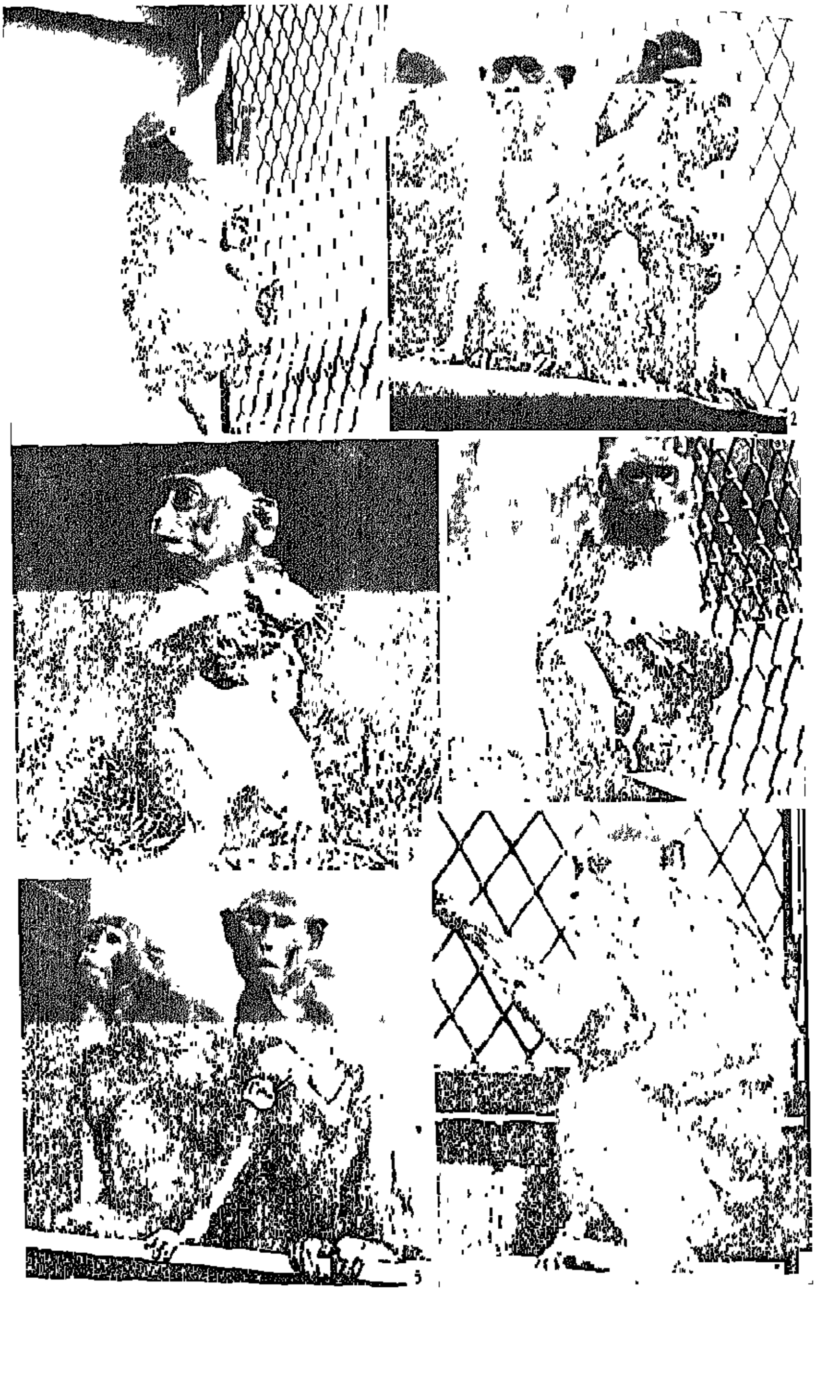
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PLATE 3

Figure 1 Baby clings undisturbed while its mother climbs about cage.
Figure 2 Female carries dead baby with no effort to place it in ventro-ventral position.
Figure 3 Psyche with her "pet" rat, which, not equipped to cling to her, was commonly held in the dorso-ventral position
Figure 4. Psyche with her premature baby which was too weak to orient itself toward her breast
Figure 5 Two monkeys with their babies, the one on the right holding to the nipple though asleep
Figure 6 Baby clinging to mother, with nipple in its mouth while it watches the camera

hesitate at times, turn its head, and stare into space (Plate 1, Figure 4) There is no evidence in this looking activity that it sees anything. Its eyes seldom fixate upon or follow any object, either still or moving, which is in the environment

The afterbirth consumed, the mother commonly stands up and walks to the water receptacle for a drink. The baby, under these conditions, clings tightly beneath the mother's breast either unaided or with the support of one of her arms Shortly after the bathing of the baby and the consumption of the afterbirth, both baby and mother yawn The mother retires to one corner of the cage, lies down with the baby still at her breast, and the two fall asleep

A few hours later the mother awakens, strolls about the cage, and stretches. The baby in the meantime clings to her breast The mother then sits down and devotes herself to a renewed examination of her infant. The licking process has ceased, for the Macacus rhesus seldom licks itself or a companion except occasionally where there is a fresh wound Instead, she devotes herself almost entirely to picking through the fur or over the skin with her small and highly coordinated fingers The mother now picks through the fur of the baby and examines its body both visually and manually She picks at any places where the hair has been matted as a result of drying fetal fluids If one or both of its eyes are swollen shut, as a result of injury during delivery, she will open the closed member and peer into it as though entranced by the shiny object Or again, as in the case of Psyche, she may extend her lips to the injured member and remove any of the excess secretions. The newborn baby reacts to these social attentions in the manner common to adult monkeys When its fur is being picked through it lies quietly and permits itself to be turned over onto its side or back, or have its legs or arms stretched out or moved into almost any position The

moment the fur picking or body examination ceases, however, the infant attempts to right itself and to renew contacts with its hands, feet, and mouth. The behavior we have described has been that typical of the full-term baby whose birth was not complicated by any abnormal factors

In the cases we observed where the infants were premature, behavior was somewhat different The baby Joshua was delivered at a copulation age of 155 days with a weight of 367 grams Though the birth was not witnessed, this baby was discovered while still wet with fetal fluids, indicating that he was approximately one hour old. At the time he was first seen he was clinging to his mother's breast with both hands and feet, demonstrating sufficient strength on his part to maintain that relationship. The mother, however, constantly supported him with one of her hands held over his shoulder The baby appeared weak and was relatively inactive. He slept most of the time, and even then he clung tightly to the mother During his waking moments he almost constantly explored the mother's fur with his mouth, but the nipple was not discovered until the second day A more extreme case was that of the baby born to the Macaca irus female, Psyche The copulation age of this baby was not known but it weighed only 220 grams and appeared to be at least a month premature in birth. When first discovered, at an estimated age of one hour, the baby had insufficient strength to hold itself to the mother's breast (Plate 3, Figure 4). The primiparous mother carried the baby about with her, picked through its fur and demonstrated the same tendencies common to the other mothers. Due to the baby's weakness, however, it most frequently was carried over the mother's arm with its back to her breast. When awake, it, like the other babies, demonstrated the tendency to seize objects with both hands and feet, and its mouth worked incessantly. But its position relative to its mother made discovery of the nipple impossible and precluded the possibility of its survival without artificial feeding In this case the only known abnormal factors consisted of the premature birth of the baby and the mother's failure to consume the afterbirth. Though we have described only two cases of this nature there are others in the history of the colony at the Carnegie Laboratory in which the behavior tends to verify the observations we report here.

The relation of the baby monkey to its mother is somewhat paralleled by that of an albino rat to the monkey Psyche who "adopted" it At the time of this incident Psyche was kept at the Psychological

Laboratory of the University of California She was without other companions and for that reason a young male rat was placed in the cage with her The two animals soon formed an attachment which persisted until the rat's death several months later Psyche carried the rat about with her in the laboratory and at times out onto the university grounds She picked through its fur, protected it from attack, and, in general, behaved toward it as a monkey mother does towards her young, even to the point of resenting its eating, a feature of the maternal behavior of monkeys which we will show further on. The rat, in turn, was dependent upon the monkey and would follow her about or run to her for protection The position of the rat in the monkey's arms, when it was being held or carried, was not determined by the monkey She would seize and draw it to her breast The rat would struggle until it achieved an upright position, but the relation of its ventral or dorsal side to the monkey's breast was purely a matter of chance (Plate 3, Figure 3). Had the rat been dependent upon the monkey's breast for nourishment, due to its inability to clasp the host and thereby turn toward the breast, it undoubtedly would have starved. In other words, the rat, for purely structural reasons, was in the helpless position of the premature monkey baby who because of weakness cannot orient itself toward the mother's breast

The behavior of long-term babies was entirely comparable to that of the typical baby we have described, except that these larger and stronger specimens achieved the same ends or demonstrated the same accomplishments at an earlier period than our other subjects.

The winking, crying, yawning, choking, grasping, and oral exploration we have just described as typical of the normal newborn *monkey occurred within the first hour or two following delivery.* The discovery of the nipple varied in the time of its occurrence Two of the babies discovered it within an hour, while the premature male, Joshua, did not take the breast until the second day, and the still more premature baby of the female, Psyche, had no opportunity to find it Having described the initial behavioral tendencies of the babies, we now turn to the modifications which occurred in their behavior during the ensuing days

Behavioral Development of Young Monkeys and Their Relations to the Mother

During the puerperium the mothers showed the effects of the extreme physical strain they had undergone. They were less active

than before and they slept frequently and for long intervals The babies, like human infants, also devoted a good part of their early days to sleep If the mothers were extremely weak, they lay stretched out on their sides, with their babies lying at their breasts If they were stronger, the mothers slept in a sitting position and the babies supported themselves at the breast with their own hands and feet, either with or without aid of a mother's arm. The better-developed babies slept either with the recently discovered nipple in their mouths, or with their heads drooping slightly against the mothers' breasts By contrast, the premature Joshua invariably had the support of the mother's arm and his head usually drooped far to one side when he was sleeping, while Psyche's still less mature baby hung over the mother's arm as limp and inert as a rag

As the mothers regained strength and their activity increased, the babies, also stronger, were stimulated to greater liveliness. Thus, by the third or fourth day, the full-term young devoted more time to staring about the outdoor cages in which they had been placed When the mothers climbed down to the floor to secure food, the young would remove their mouths from nipples, and straighten their arms and legs so that they hung pendulously under the mothers. In this position they stared about, and at times reached out with a hand as though seeking something to grasp. By the eighth to tenth day the normal young were beginning more extended exploration When the mothers took a sitting position they would climb to the floor and in an awkward fashion walk a few inches away

The writers paid particular attention to the mothers Nos 2 and 49 and their babies, who were caged together. Nina, the baby of 49 was born on April 9, and Pola, the daughter of No 2, on April 19 The behavior of these four animals provided interesting examples of mother-child relationships not unparalleled in human beings. No 49 was an unusually kind and tractable animal whose affectionate disposition was demonstrated both to her offspring and to her observers No 2, on the other hand, was somewhat nervous and irritable They were both multiparous, of approximately the same age, and in equally splendid physical condition Their attitudes toward babies, however, were as different as their temperaments Almost from the first, No. 49 was the slave of her baby If it squirmed in discomfort because of her position, she moved about until the baby was quieted No 2, under the same conditions, would withstand the irritation of Pola for a time and then brusquely

slap the infant or shove it over into a new position The behavior of the two mothers was typical in various other circumstances which arose.

By the first of May both of the babies were beginning to explore the cage independently Nina would walk a few inches away from her mother and then suddenly turn and rush back to her. On one occasion the four animals were on top of their quarter's shed Nina walked toward the edge of the building No 49 rushed over, seized her, and carried her back to a corner Pola, in the course of her explorations, approached the same point. No. 2 looked on, but made no move to stop her.

On the afternoon of May 1, when food was placed in the cage, the two mothers descended from the top of the quarter's room, carrying their babies Pola persisted in getting down from her mother and sampling the food The mother objected and drew the baby to her breast The baby again descended and was again drawn back, but this time more forcibly. After this behavior had been repeated several times and Pola was again about to drop down from her mother, No 2 clasped the infant tightly to her with one hand, and then pitched violently up and down, much as a horse does when trying to dislodge its rider. Pola clung tightly for a time and then started to relax her hold on the mother's breast Again No. 2 went through the pitching behavior, and this time even more violently The baby appeared to have learned its lesson for one day, and held itself close to the mother Nina on this same day got down and sought to sample the food No 49 seized the food and then drew the baby up to her breast After several repetitions of this the mother filled her pouches and one hand with food and took her baby with her to a far corner of the cage away from the main food supply

Differences between the mothers were also demonstrated by their reactions to each other's baby As the babies began to walk about, during the first days of May, they would frequently go to either of the adult females If Nina approached and started to climb onto No. 2 this female would brush her roughly aside, if necessary, shaking or slapping the baby to drive it away If, on the other hand, Pola went to No 49, she was accepted and cuddled with the same attentiveness which that female accorded to her own baby This situation resulted in a rivalry between the otherwise friendly mothers No. 2 would at times rush with bared teeth to rescue Pola

from the attentions of the other mother. For days No. 49 continued to solicit the attention of Pola at the cost of repeated threats from that baby's mother. Finally, by the middle of May, she seemed to have adjusted herself to the situation, and the two mothers were concentrating their attentions upon their own infants

The different maternal attentions of these two mothers seemed to be reflected in the behavior of their babies. The latter developed tendencies one would expect from human children under similar conditions Nina was soon a highly dependent, timid, and unaggressive baby, while Pola was active and self-assertive.

The same type of situation was demonstrated in the case of two other monkey mothers and their yearling sons Between these mothers and babies there existed similarly varied relationships. Female No. 36 was the fond and doting mother of the yearling male, Harry Her arms were open to all babies Much of her time was spent rescuing her now strong and active son from possible sources of danger, or in petting and fondling him. Susie, No 7, was the "matter-of-fact" type of mother, who, though always a point of refuge for her yearling son, George, was never overly solicitous of his welfare She violently resented the approaches of the other young male Both of the yearling babies were still carried at the mothers' breasts at times They frequently clung to the nipples with their mouths, though the mothers were undoubtedly without milk. When Harry was frightened by the sudden appearance of an observer, or by strange sounds, he ran shrieking to his mother, leaped to her breast and then, after seizing the maternal nipple in his mouth, looked around toward the cause of his fear. The seizing of the nipple in his mouth had apparently become essential for a feeling of complete protection Both of the mothers accepted their young under these conditions If the source of fear proved to be an observer, or if the startling sound was not repeated, No 12 would soon disengage her son and force him from her. No. 36, on the other hand, would usually cuddle and fondle her baby and carry him about until he voluntarily withdrew from her If No 12 was not accessible at the time of a fear situation, both of the babies would rush to No. 36 and she would take them both to her breast. If the situation was reversed, however, only George could go to No. 12, and Harry could not so much as hide close behind her. The result of these widely divergent maternal attitudes seemed to be reflected in the two babies. Thus George

was an active, aggressive, and relatively independent young monkey, while Harry was a slinking, timid, dependent creature, who rushed to his mother at the least disturbance, and was afraid of almost everything

On April 12, No 36 was taken from the paddock on the fifth story roof of the laboratory and placed in a cage on the laboratory grounds. This left Harry and George with the one female, No 7 Time after time the now motherless Harry rushed to No 7 for protection, but she always drove him away, sometimes biting him severely to accomplish her end. Deprived of this source of protection when frightened, the young male would rush into the nest box, or seek a remote corner of the cage where he would crouch motionless until he found himself discovered, or the source of his fear disappeared His mother, in the meantime, though caged with a dozen or more females, spent most of her time on a perch staring up toward the roof of the building and calling to her son The behavioral make-up of the four babies we have just described seemed to be determined largely by the attitudes of their mothers toward them

Sensory-Motor Development of the Young

During the course of this investigation we had opportunity to make observations on the sensory-motor development of three babies during the first two weeks of their lives The subjects were Joshua, premature, and Nina and Pola, both full-term babies who were apparently normal in all respects. In each case the baby was taken from its mother by force, with resultant emotional disturbances which undoubtedly tended to reduce the accuracy of our determinations. Each baby was taken into a small experiment room and as many tests as possible were made in rapid order so as to avoid tiring the subjects.

The simple facilities we had available for these tests and our methods of using them were as follows·

Pupillary reflexes were determined by the use of an ordinary flashlight. Visual pursuit movements were tested by the use of both the flashlight and six-inch squares of white cardboard which were moved slowly at varying distances from the subject's eyes A single test of olfaction was made by the use of an open bottle of oil of cloves which was presented to the subject's nostrils. To test the winking responses experimenters moved lead pencils or their hands rapidly up to or past the eyes of the subject A cardboard

cylinder 22 inches in diameter and 10 inches deep, bearing one-inch wide, vertical black stripes on the inside, was revolved slowly about the subject to test for optical nystagmus. The subjects were also revolved on a stool to test for the same response. Tendencies to orient or climb upward were studied by releasing the young subjects in contact with a vertically held broomstick, and by placing them upon a reinforced sheet of building board which could be tipped at various angles. The results of these tests are shown in Table 1

The lid reflex is reported only for the baby Pola and in her case on and after the eighth day. Though all of the babies we observed began to wink during or very shortly after delivery, they failed to respond in this manner on the basis of visual stimuli provided by objects moved rapidly toward or in front of their eyes They did respond, however, whenever contact was made with the face or when the eyes were blown into. Tests for nystagmus gave positive results when the subjects were rotated but not when the visual field was revolved about them The evidence secured from the lid re-

TABLE 1

SENSORY-MOTOR RESPONSES OF THREE BABY SUBJECTS STATED IN TERMS OF THE DAYS OF THEIR APPEARANCE

	Pupillary response	Lid response	Visual pursuit	Nystagmus—revolving cyl	Nystagmus—rotation	Olfactory	Pinna response	Start response	Standing	Walking	Upward climbing on platform	Upward climbing on stick
Joshua .	3	—	11	—	11	3	4	18	3	5	4	3
Nina .	2	—	5	—	7	2	2	10	1	1	1	2
Pola	2	8	5	—	6	2	2	7	1	1	2	1

action and nystagmus tests indicates slow development of visual functions Pinna and start responses were secured with auditory stimuli. The pinna response appeared first It grew into the start response in a stepwise fashion First, there was ear movement; second, ear and head; third, ear, head and fore limbs; and finally, after intervals of from 5 to 14 days, the start response involved the entire body.

The development of locomotor ability was slow *and seemed to* depend more upon increasing strength of the organism than upon

practice. When Joshua, the premature baby, was first placed upon the floor of the experiment room at the age of one day, his legs spread out in spider fashion and he was without sufficient strength to bear his own weight in a standing position. This is in contrast with the full-term baby Nina who, it will be remembered, stood up unsupported within an hour of the time of birth. All of the subjects, Joshua included, were able to right themselves on a smooth surface from the time of birth, though there were marked differences in the readiness with which this act was accomplished. They were hampered in this behavior by their tendency to clasp their hands and feet together (Plate 2, Figure 6). Until the clasping tendency was inhibited, they turned themselves over almost entirely by bodily squirming.

The tendency to climb upward was interesting because of the known fact that most monkeys in their semi-arboreal existence take flight into trees when frightened. When the baby subjects were placed alone upon the floor of the experiment room they immediately began to cry loudly and to move slowly toward the walls of the room or toward any furniture which was near at hand. Upon reaching one of these they attempted to climb upward (Plate 2, Figures 3 and 8). When they were released in contact with a vertically held broomstick, each of them climbed upward as soon as its physical strength made that possible. When placed on a platform inclined at an angle of approximately 20 degrees they oriented upward at ages varying from one to four days (Plate 2, Figure 5). While they were so weak that their legs spread out in spider fashion this behavior was not observed. On the other hand, after they were able to walk with assurance the reaction disappeared. This indicated that their orientation tendency on the inclined plane was due, not to the bilateral symmetry, which is the basis of tropistic responses, but to differences in the development of the flexor and extensor muscles of their limbs. Within two hours of birth, the premature baby, Joshua, could hang by one arm or leg, frequently flexed, for two or three minutes at a time. In the same manner Nina held both herself and the 380-gram Joshua when she was but three days old (Plate 2, Figures 1 and 2). The remarkable strength of the flexor muscles was demonstrated in these instances before Joshua was able to stand and before Nina could walk.

It appears that the tendency of monkeys to climb upward is un-

learned and furthermore that it is not tropistic in nature. The latter assertion is justified only upon the basis of definition In our judgment the fact that a cat's claws are so constructed that it can climb up a tree more readily than it can descend does not justify us in regarding the cat as negatively geotropic. In the same manner, we feel that the upward-climbing tendency of baby monkeys is due to non-uniform neuro-muscular development and, therefore, is not evidence of negative geotropism

From the observations we were able to make on the sensory development of young monkeys, we agree in large part with the conclusions drawn by Kuroda (6) who found that the cynomologus monkey he studied had received practically a complete sensory equipment by the end of five days The development of the M rhesus baby observed by Lashley and Watson (7) closely paralleled our premature subject, Joshua

Sensory-motor coordination develops more rapidly in the baby monkey than in the human infant, but less rapidly than in lower organisms with which we are familiar. Our inability to keep our subjects under constant observation for several weeks after birth makes it impossible for us to describe the development of their more complex activities The observations of Lashley and Watson and some of our own are enlightening concerning these. When the baby subject of the former observers was being carried under its mother at the age of 11 days, it frequently reached forward and seized at her moving hand, tripping her. Similar behavior occurred with the babies Nina and Pola when they were between one and two weeks old. Lashley and Watson's subject walked for the first time on its twelfth day, while our mature subjects walked on their first day and the immature Joshua moved clumsily about by his fifth day Awkward attempts to scratch the head or shoulders with a hind foot appeared during the second week. This activity, though thought of as being entirely reflex in nature, was usually unsuccessful at first, and was not performed smoothly and with readiness until after numerous repetitions extending over 10 or 12 days

Play activities, consisting largely of romping, jumping, and attempts to leap upon and seize objects, appeared in our subjects during the second and third weeks In this behavior the subjects demonstrated lack of eye-hand coordination and distance perception. Frequently, both Nina and Pola reached out with their hands to touch a wall of their cage when it was six or eight inches beyond their

reach In the same manner, in reaching for an object on the floor before them, they commonly missed it by as much as two or three inches. On her 21st day Nina attempted to leap up onto the wire screen of her cage two feet away from her. The distance was underestimated and she fell to the floor a full foot short of her mark The yearling babies, George and Harry, while both strong and active, were still awkward and poorly coordinated in many of their activities. George was a capable swimmer and indulged in this activity whenever a pail or other receptacle filled with water was accessible to him. In spite of their general development, however, they frequently misjudged distances when they leaped from one place to another and when they attempted to seize objects quickly.

Emotional Responses

In the course of our experiments with the three baby monkeys they were subjected to various stimuli, such as loud sounds produced by clapping boards together, and suddenly appearing objects, such as coats or burlap bags dropped before them So long as a subject was clinging to some object with both hands and feet these stimuli aroused no emotional responses (Plate 2, Figures 4 and 8). In the course of our work with them, however, we found that as soon as a subject was prevented from making its grasping, contact reactions, it cried and struggled in a manner indicating fear. If, on the other hand, it was thwarted in its movements by either the observers or its mother, it responded by quick bodily jerks which were probably indicative of either anger or rage

On one occasion a live garter snake was placed in the paddock with Nina and Pola and their mothers To our surprise neither the mothers nor the babies demonstrated fear of the reptile. The mothers followed it about the cage and only when it moved quickly after being touched by one of them did they withdraw from it in any manner The babies, which were at that time between a month and six weeks old, were interested in the snake and had they not been restrained by their mothers would have stepped on or seized hold of it

Human infants observed by Watson (10) gave fear reactions to sudden removal of, or changes in, their means of support, and to loud sounds. Rage was elicited in them only by thwarting their movements The failure of our monkey babies under two weeks of age

to respond to loud sounds may have been caused by incomplete development of their auditory apparatus Inhibition of contact-making reactions for the monkey babies was comparable to removal of the source of support for Watson's human baby subjects. Our data indicate that the initial emotional responses of monkey babies are similar to those of human babies both in their nature and in the stimuli which evoke them

Discussion of Results

Biologically, the primate baby is commonly thought of as being parasitic until birth, at which time it emerges as a free-living though dependent organism In our study of baby monkeys we find that this concept is not entirely true in the sense in which it is accepted The fetus is, without doubt, parasitic. It preys upon its host until, because of yet unknown maturational factors, the processes which result in its delivery begin their operation In the case of the monkey baby, if it is normal, activity may occur during the course of delivery It may reach out with its arms as soon as they are disengaged and seize hold of any objects in the immediate environment. It is conceivable that the baby born in the native state might in this manner support itself and thereby avoid falling from its arboreal birthplace. But this grasping behavior serves still another purpose in the scheme of things in monkeydom If the baby is to survive, it must secure nourishment from the mother. The mother gives manual aid to the delivery of her baby, brings it up before her, and there licks the fetal fluids from its body Regardless of its strength or weakness, factors commonly related to the conception-age of the baby at birth, the mother carries it with her But the baby itself, by its grasping behavior, determines its position relative to the maternal breast. It orients and holds itself in the ventro-ventral relationship. It explores the mother's fur with its mouth and discovers the nipple. Its behavior alone determines both how and when it shall take nourishment In other words, behaviorally, and from a nutritional standpoint, the baby suckles the mother, the mother does not nurse the baby In that sense the baby remains parasitic even after birth.

There is reason to question the innateness of the suckling response in the monkey. As we have shown, in our baby subjects the incisor teeth commonly erupted during the second or third week We have also described the incessant movements of their mouths during

their waking hours If the finger of an observer was placed in the mouth of a baby, the subject usually bit down upon it repeatedly, with little or no evidence of sucking. The early responses of many of the babies to the nipple seemed to be of the same nature This indicated that tender or irritated gums were the stimulus for the initial mouthings of the breast. We could not determine whether sucking behavior appeared automatically and full fledged, or whether swallowing and sucking responses were set off when milk was accidentally secured through the biting behavior.

The rôle of instinctive behavior in the mother-baby relationship is not at all clear We have previously shown (10) that the mother discovers the fetal fluids in the course of manual exploration during delivery She licks these from her hands and, after delivery, from the baby's body She also licks them from the floor of the cage and from the afterbirth The afterbirth, which is both covered and permeated with the same ingredients, she consumes Licking is not the behavior used by monkeys in the cleaning process. With them, licking is a food-getting act It seems probable, therefore, that the baby's "bath" is performed entirely for the sake of the mother.

The mother does cling to and, if necessary, fight for the possession of her baby The monkey Psyche behaved in exactly the same manner with the white rat which she "adopted" and carried about with her for months In some of our own cases and in the one observed by Yerkes (12), monkey mothers clung to and fought to retain stillborn babies even after decomposition had set in. But they also may fight to retain afterbirth, food, or other coveted objects

The fact that the mothers permit the young to suckle is not necessarily evidence of maternal instinct, for it may be assumed that all mammalian mothers derive a certain pleasure from this act Furthermore, the monkey mothers resent other food-taking activities of their young until the babies by sheer persistence break down their interference Psyche, it will be remembered, also resented the taking of food by her rat

On the other hand, in the face of this contradictory evidence, it must be pointed out that there is much behavior in the complex mother-baby relationship which we are unable to explain in so simple and mechanistic a manner Soon after delivery some of the mothers fondle and pet their babies and seem to demonstrate actual pride in exhibiting them The young are protected, not merely from escape or from being taken away, as would be the case if they were merely a possession, but also from injury and molestation.

Summary

The normal monkey baby becomes active before his body has been completely delivered. His eyes open and close, he cries and reaches out and grasps objects with his hands.

At birth the flexor muscles of the limbs are more highly developed than the extensors, enabling the young to support more than double their own weight by one flexed arm, though they stand or walk with difficulty

Contact-seeking and the seeking of bodily support are the principal drives of the newborn monkey These are demonstrated by grasping and clinging behavior, with both hands and feet, and by seizing and biting upon objects with the mouth.

All sensory modalities of full-term babies appear to be functioning by the end of the first week. Premature babies are weaker and develop less rapidly.

The initial emotional responses of monkey babies are similar to those of human babies both in their nature and in the stimuli which evoke them

The tendency to climb upward when frightened appears by the second day. The young orient upward on an inclined plane before they are able to walk readily. This is attributed to the weakness of their extensor muscles rather than to any tropistic tendency

The monkey does not cease to be parasitic upon birth. It achieves the ventro-ventral position relative to the mother by its grasping behavior, discovers the nipple unaided, and determines how and when it shall nurse. If the baby lacks sufficient strength to accomplish these ends itself, it perishes.

There is question as to whether suckling appears instinctively or is acquired after milk is secured through "mouthing" activities at the breast.

Much of the behavior involved in the mother-baby relationship is subject to mechanistic explanation.

References

1. Fox, H The birth of two anthropoid apes *J Mammal*, 1929, **10**, 37-51
2. Hartman, C G The period of gestation in the monkey, M rhesus, first description of parturition in monkeys, size and behavior of young. *J Mammal*, 1928, **9**, 181-194
3. ————. Uterine bleeding as an early sign of pregnancy in the monkey (M rhesus), together with observations of the fertile period of the menstrual cycle *Bull. Johns Hopkins Hosp.*, 1929, **44**, 155-164

4 ———— The period of gestation in the monkey, M rhesus *Anat Rec.*, 1929, **44**, 226

5. ———— The fertile period of the menstrual cycle in the monkey, M. rhesus. *Anat Rec*, 1929, **44**, 226

6 ————. Studies in the development of the opossum V The phenomena of parturition *Anat Rec*, 1920, **19**, 1-11

7 KURODA, R Untersuchungen uber die korperliche und sinnesphysiologische Organisation eines neugeborenen Affen (M cyn) *Acta Psychol Keijo*, 1930, **1**, 3-16

8 LASHLEY, K S, & WATSON, J B Notes on the development of a young monkey *J Anim Behav*, 1913, **3**, 114-139

9*a* SPIEGEL, A Biologische Beobachtungen an Javamakaken, M irus *Zool Anz*, 1929, **87**, 45-65

9*b*. ———— Beobachtungen uber den Sexualzyklus, die Graviditat und die Geburt bei Javamakaken *Arch f Gynakol*, 1930, **142**, 561-591

10 TINKLEPAUGH, O L, & HARTMAN, C G Behavioral aspects of parturition in the monkey, M rhesus *J Comp Psychol*, 1930, **1**, 63-98

11 WATSON, J B Psychology from the standpoint of a behaviorist (2nd ed) Philadelphia. Lippincott, 1924. Pp ix+429

12 WHITE, B A. A captive born chimpanzee. *Sci Mo*, 1929, **6**, 558-565

13. YERKES, R M Maternal instinct in a monkey *J Anim Behav*, 1915, **5**, 403-405

14 YERKES, R M., & YERKES, A W. The great apes New Haven, Conn. Yale Univ Press, 1929 Pp xix+652.

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LE COMPORTEMENT ET LES SOINS MATERNELS DU SINGE NOUVEAU-NÉ (MACACA MULATTA—"M. RHESUS")

(Résume)

Le singe normal nouveau-né devient actif avant que son corps ne soit complètement né Les yeux s'ouvrent et se ferment, il crie et étend les mains *et saisit des objets.*

A la naissance les muscles fléchisseurs sont plus développés que les extenseurs, ce qui permet aux jeunes de soutenir plus que deux fois leur propre poids par un bras *fléchi, quoiqu'ils se tiennent debout ou marchent avec* difficulté

La recherche des contacts et la recherche des soutiens due corps sont les efforts principaux du singe nouveau-ne. Il montre ceux-ci, en saisissant et en se cramponnant avec les mains et les pieds, et en saisissant et en mordant des objets avec la bouche

Toutes les modalites des sens fonctionnent, paraît-il, chez les nouveau-nes qui sont nés au terme ordinaire, à la fin de la première semaine Les singes nés prématurément sont plus faibles et se développent moins rapidement

La tendance à monter sous l'influence de la peur se montre le deuxième jour Les jeunes montent sur un plan incliné avant d'être à même de *marcher facilement Cela s'explique par la faiblesse des muscles extenseurs* plutôt que par un tropisme

Le singe ne peid pas ses habitudes parasitaires après la naissance Il trouve la position ventro-ventrale avec sa mère pai son action de saisir, découvre la mamelle sans aucune aide, et decide la manière et l'heure de son alimentation. Si le nouveau-nc n'a pas assez de forces pour faire ces choses lui-même, il meurt

One ne sait si l'action de se nourrii est instinctive ou si elle est acquise après que le nouveau-né a obtenu du lait par les mouvements de sa bouche a la mamelle.

Beaucoup du comportement montié dans la relation de la meie et du nouveau-né se prete à une explication mécaniste

TINKLEPAUGH ET HARTMAN

TATIGKEIT UND MÜTTERLICHE PFLEGE DES NEUGEBORENEN AFFCHENS (MACACA MULATTA—"M RHESUS")

(Referat)

Das noimale Affchen fangt an, sich zu betatigen noch ehe sein Korper vollig geboien ist Seine Augen offnene und schliessen sich, es schreit, langt aus, und erfasst Gegenstande mit den Handen

Zui Zeit der Geburt sind die Beugemuskeln der Glieder volliger entwickelt als die Streckmuskeln, so dass es den jungen Tierchen moglich ist, mehr als das Doppelte ihies Gewichtes mit einem gebogenen Aim zu unterstutzen, obwohl sie nur mit Muhe stehen und laufen konnen

Das Suchen nach enger Beruhrung und korpeilicher Unteistutzung sind die wesentlichen Tiiebe des neu-geborenen Affchens Diese Triebe weiden in den Tatigkeiten des Erfassens und des Anklammeins sowohl mit Handen wie mit Fussen, und im Erfassen und Anbeissen von Gegenstanden dargestellt

Alle Sinnesmodalitaten voll-entwickelter neu-geboiener Affchen scheinen schon am Ende der ersten Woche tatig zu sein Vorschnell geborene Affchen sind schwacher und entwickeln sich nicht so schnell

Die Neigung, nach Erschreckung aufwarts zu klettern, zeigt sich schon am ersten oder zweiten Tage

Die Jungen orientieren sich aufwaits eine schiefe Ebene entlang, noch ehe sie gut laufen konnen. Diese Neigung ist ehei auf die Schwache ihrer Streckmuskeln als auf eine etwaige tropistische Tendenz zuruckzufuhren

Das Affchen hort mit der Geburt nicht auf, paiasitisch zu sein Es bewirkt durch die Erfassungstatigkeit (grasping behavior) die ventro-ventral Lage der Muttei gegenuber, entdeckt ohne Hilfe das Saughutchen, und bestimmt die Weise und Zeit des Saugens Fehlt es dem Tierchen an genugend Starke zur Selbsbewirkung dieser Ziele, so stirbt es

Es ist eine Fiage, ob das Saugen sich instinktiv zeigt odei ob es geworben wird, nachdem Milch durch Mundbewegungen an dei Brust erhalten wird

Vieles an der Tatigkeit die im Verhaltniss zwischen Mutter und Kind in Anspiuch genommen wird, lasst sich mechanistisch erklaren

TINKLEPAUGH UND HARTMAN

AN EXPERIMENTAL STUDY OF EARLY CHILDHOOD MEMORY*

From the Psychological Laboratories of the Ohio State University

HAROLD E. BURTT

INTRODUCTION

There have been numerous reports as well as informal collection of data regarding the earliest period in life which a person can remember. The data usually take the form of memory for some particular event which can later be placed chronologically by other criteria. The obvious difficulty is that actual memory for the event may be confused with memory of accounts of the event which have been related by the child's parents. A crucial experiment necessitates the use of material which can be checked objectively in such a way as to eliminate all possibility of others coaching the subject. The general program of the present experiment was to present nonsense material to the subject in infancy and early childhood and later conduct learning experiments with this material as contrasted with other material of similar character which had not been presented in infancy. If the material which had been presented at the outset was relearned more readily than the new material was learned this would indicate some memory effect produced by the first presentation.

MATERIAL

Passages from Sophocles' *Oedipus Tyrannus* in the original Greek were used as material. This was tantamount to nonsense material for the subject. Furthermore, no members of the family or relatives who might overhear the experiment had any knowledge of Greek so that there would be little opportunity for anyone subsequently to coach the subject deliberately or inadvertently. The material being in the same meter and dialogue form was presumably fairly uniform in difficulty throughout. Selections were taken from scattered points throughout the play. No choruses were used, but merely dialogue portions, all in iambic hexameter. Each selection involved approxi-

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mately 20 lines, 240 syllables. Occasionally there were a few syllables more or less than that due to the inclusion of more than two syllables in a measure. Moreover, a slightly longer cue was necessary at the beginning of some selections because several of them were rather similar in the first words. In one or two instances slight variations in length were made in order to preserve the unity of the selection. On the average, however, the actual number of syllables learned in the original passages and the new passages differed by only three syllables—less than 1 per cent.

Method

The subject[1] was a boy with an IQ of approximately 130 based on the average of periodic Binet examination. Twenty-one passages similar to those above described were selected for the original presentation. Beginning at the age of 15 months three of these passages were read once daily to the subject for a period of three months, a total of 90 repetitions. The reading was at as uniform a rate as possible, approximately 2 seconds per line. At the age of 18 months these three passages were dropped and three more read daily for three months. This procedure was continued until the subject was three years old. Only one of the three passages used at each age level was used in the relearning tests which are reported in the present article. Other selections which were presented at these ages are available if the subject ever cares to conduct another similar experiment.

The selections are indicated by Roman numerals in Table 1, and in the second column is given a schedule of the original reading. For example, selection No. III was presented originally from 15 to 18 months. The subject was always kept in a situation as conducive as possible to maximal attention to the reading. No toys or playthings were permitted and no activity such as running about was allowed, although minor squirming and restlessness could not be controlled. In the later portions of the original reading, of course, the subject began to take the procedure as a matter of course and called it his "Greek lesson."

After the subject reached the age of three years, the entire matter was dropped until he was 8 years and 6 months of age. No one else had heard enough of the material to be able to recite any of it and the experimenter of course did not mention it. At the age of 8 years

[1]The writer acknowledges his obligation to Benjamin P. Burtt, who served as subject in this rather tedious experiment.

TABLE 1

Selection	Age in months for original reading	Repetitions till all words anticipated	Repetitions till recited entire
III	15–18	361	382
VI	18–21	250	253
IX	21–24	376	385
XII	24–27	355	379
XV	27–30	304	328
XVIII	30–33	217	226
XXI	33–36	259	265
Av		303	317
Av of III, VI, IX		329	340
Av of XII, XV, XVIII, XXI		284	299
A		409	409
B		445	451
C	. .	436	445
Av.		430	435

and 6 months the experiment on relearning began. For this purpose the 7 selections noted in the table—one from each age level—were used and three new ones of the same average length and meter and presumably of approximately the same difficulty. The nature of the experiment was explained to the subject and his cooperation was adequate He was not told, however, which passages were new and which were old, so that there would be no difference in motivation. He did not have any correct suspicion on the matter as evinced by the fact that when the experiment was over and the results were explained he showed considerable surprise at the information as to which passages were new and which were old

The order of presenting the ten selections in each trial was varied systematically The first trial was in the order A, B, C, 21, 18, 15, 12, 9, 6, 3 The next was B, C, 21, 18, 15, 12, 9, 6, 3, A The next was C, 21, 18, 15, 12, 9, 6, 3, A, B, etc. Thus, in each succeeding trial the selection which had been at the first of the preceding list was now at the last of the new list Ten trials completed this cycle whereupon it was repeated and this procedure gave each selection an even chance of any advantages which might be due to primacy or recency or any disadvantages of retroactive inhibition or similar processes. The trials were not run on an absolutely regular schedule It was desired, as far as possible, to have them once daily but there were unavoidable interruptions. On occasion two trials would be given daily when time was available, but on every trial the ten se-

lections were always given with the usual 15-seconds pause between them.

For the first 17 trials the experimenter merely read the selections in the same fashion they had been read at the outset Beginning with the eighteenth trial the prompting method was adopted as follows. The selection was read very slowly and the subject supplied any words which he could at the proper point As the experiment progressed the subject would be reciting more and more words and phrases and the experimenter would merely be supplying the missing parts On the nineteenth trial it was realized that a tremendous amount of time would be consumed if the prompting method was used on every individual trial and that probably very slight differences would be found from one trial to the next anyway Consequently, the procedure was modified so that the experimenter read all the selections for two trials at the standard rate of 2 seconds per line and then the third trial was devoted to the prompting method. This arrangement was maintained until the end of the experiment so that trials 19, 22, 25, 28, etc , were prompting trials and the learning data were tabulated on the basis of these trials.

As the words were learned they were underlined in the book and the date noted on which they had been anticipated correctly This procedure was continued until every word in the selection, with the exception of the initial cue words, had been anticipated A record was made of the number of repetitions necessary up to this point In most cases the subject was not at this time able to recite the entire selection without prompting and further repetition on the same schedule was made until he recited the selection from beginning to end with no prompting. This number of trials then was recorded as the final score Due to the way the repetitions were distributed it was about 11 months until the first selection had been completely learned. It was then dropped from the schedule It was about 16 months before the last selection had been perfected It was possible that there was a little greater incentive toward the end of the experiment as the subject realized he was getting some of the selections out of the way. The effect of this greater incentive would be, if anything, to complete the more difficult selections earlier than they normally should have been If any correction were to be made for this it would probably take the form of delaying the correct scores in the later trials so that the results hereinafter reported might perhaps be more significant even than they appear

Results

The principal results are summarized in Table 1. The first two columns have already been explained. The third column gives for each selection the number of repetitions that were necessary until all the words had been correctly anticipated. As explained above, the subject might not be able to recite the passage entirely at that time. The figures in the last column give the number of repetitions necessary before he recited the entire selection without prompting. The upper block of the table with the Roman numerals involves the selections which had been presented in infancy or childhood, while the lower block gives the three new selections, A, B, and C, which were learned *de novo*.

Perhaps the clearest way to note the general tendency is to average the results of each block of the table. The results are rather striking, with 430 repetitions necessary for the new material as against 303 for the old from the first standpoint, and 435 and 317, respectively, from the second. These differences are 42% and 37%. It may be noted that there is no overlapping of the two distributions. The most rapid learning is for selection 18 with repetitions of 217 and 226 by the two criteria of learning. The values contributing to the averages in the upper part of the table are naturally rather scattered because different amounts of memory might be expected due to the varying lapse of time since the original presentation and the age of the subject at that presentation. Nevertheless, if we disregard this fact and average the memory scores for the original selections, it appears that we do have real differences between such scores and the memory for new selections. With small samples of this sort the accepted procedure is to use Fisher's t-function (1, pp. 107 ff.). For the averages of 303 and 430 repetitions necessary until all the words had been anticipated the value of t is 3.34 which gives almost exactly 99 chances out of a 100 that the difference between the averages is a real one. For the averages in the last column, t is 2.86 which gives a probability of about 98 out of a 100 that the difference is real. As mentioned above, the high variability of the relearning data is to be expected anyway, because of the different conditions of the original learning. Even so, the differences between the averages are significant.

It is interesting to divide the upper portion of the table into two parts—the three selections presented earliest of all, III, VI, IX, and

the remaining four Averages of these are given All of them, of course, are smaller than the corresponding average for the new selections A, B, and C. The earliest selections, III, VI, and IX, required more repetitions than the later ones. All four averages differ significantly from the A, B, C averages with the possible exception of the difference between 340 and 435 in the last column, when the probability is only .90 that the difference is real. The difference between the averages for earlier and later selections, 329-284 and 340-299, are of somewhat doubtful statistical significance.

Again, if we consider the individual scores, there appears somewhat of a trend for the selections which had been presented originally at a later age to be remembered better than those presented at an earlier age Selection 6 is a definite exception to this trend but otherwise we note a general decrease in the magnitude of the entries in the table as we go down the column. If we simply rank the seven values in either column and compare those ranks with the actual order in which the rows are listed, i.e., the original order of presentation, we get a correlation by rank difference squared formula of 50±.19 Again if we simply correlate the values in a given column with the age and month in which the original reading was begun, namely, 15, 18, 21, etc , in the second column, we get a correlation of .55± 18 for repetition until all words are anticipated and a correlation of 52 ± 19 for repetition until the entire selection is recited. This trend conforms to what we might expect, viz , that the selections which had been presented at the earliest age were retained least effectively

Some learning curves are presented in Figure 1 The abscissa is laid off in units of 30 trials. At each such point the ordinate corresponds to the number of syllables correctly anticipated up to and including that trial. The lowest curve is the average of the three new selections, A, B, C For example, the three scores on the 43rd trial average 40, and this value is plotted on the ordinate. After a selection is learned its maximum score still contributes to the average The seven original selections are divided into two groups, the three that were given earliest in infancy and the four later ones One curve is plotted for the average of the former—III, VI, and IX—and one curve for the average of the latter—XII, XV, XVIII, and XXI

The curves are rather close together We might take any two corresponding ordinates and determine whether they differed significantly, e g., whether the superiority of the average of selections

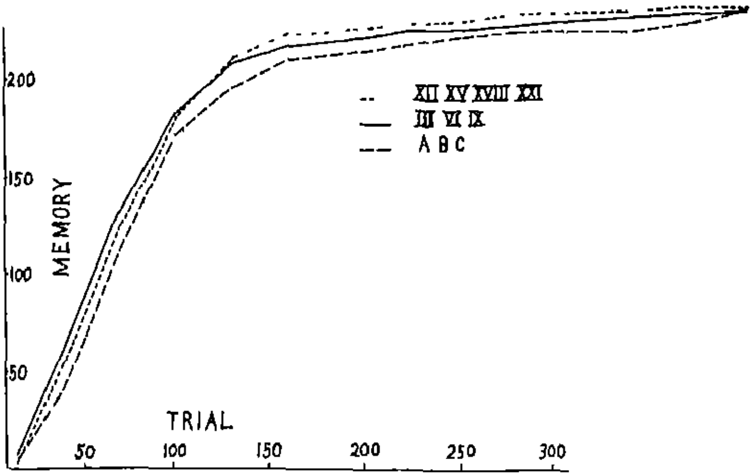

FIGURE 1

21, 18, 15, and 12 to the average of A, B, and C on the 43rd trial was a real difference. Making such analysis by means of the t-function, none of the differences are significant with one exception. However, some weight must be attached to the fact that the A, B, C curve is consistently lowest of all. The curve for the selections presented later in the original reading starts below the curve for the earlier selections but goes above it on the 133rd trial and remains there.

The individual curves are not included in the figure. For the new selections the curve for A is a little above the average curve presented, B is somewhat inferior and C follows the average rather closely, although it drops below it in the middle portion of the curve. Of the seven curves for the original material, selection No. 18 is slightly above all the rest throughout, selection No. 9 is rather inferior to the others in the middle range, and the rest are rather closely bunched throughout. There is much overlapping and no clear-cut evidence of a hierarchy from this standpoint. However, the superiority of the selections that were presented originally to those that were learned *de novo* seems reasonably clear in the curves and the results given in the table are still more striking. The conclusion seems warranted that it is possible to present nonsense material to a child as young as a year and a half and by 90 repetitions distributed

over a period of three months produce an effect which will manifest itself in a relearning experiment seven years later.

Summary

Meaningless material (20-line selections of Greek drama) was read aloud to the subject daily, beginning at the age of 15 months. Every three months a different set of similar selections was used as material, and this procedure was continued till the age of three years. When the subject was 8½ years of age he learned this original material by a modified prompting method and at the same time learned other similar material *de novo*.

Whereas the new material required on the average 435 repetitions per selection, the material which had been presented in infancy and early childhood required 317. The original selections which had been presented later in childhood were learned more rapidly than those presented earlier but even the material that had been presented to the subject daily between the ages of fifteen and eighteen months showed a fairly clear effect of this early experience in facilitating subsequent learning.

Reference

1. FISHER, R. A. Statistical methods for research workers. London: Oliver & Boyd, 1930. Pp. xi+269.

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UNE ÉTUDE EXPÉRIMENTALE DE LA MÉMORIE DES PETITS ENFANTS

(Résumé)

La matière expérimentale s'est composée des morceaux choisis de l'Oedipus Tyrannus de Sophocle en grec, chaque morceau etant de 20 lignes. On a lu trois morceaux une fois par jour à un sujet mâle, en commençant à l'âge de 15 mois et continuant pendant 3 mois. Puis on a substitué d'autres morceaux et les a lus une fois par jour pendant trois mois, substituant encore d'autres après. On a continué ce procédé jusqu'à l'âge de trois ans. On a cessé l'expérience depuis cet âge jusqu'à l'âge de 8½ ans. Dans l'expérience du réapprentissage on s'est servi d'un morceau du groupe lu à chaque niveau d'âge,—donc 7 morceaux. Ils ont été appris par une méthode modifiée de souffler. En même temps les sujet apprenait 3 morceaux semblables qu'on ne lui avait pas lus dans sa petite enfance. On a varié systématiquement d'épreuve en épreuve l'ordre des 10 morceaux.

Les 3 nouveaux morceau ont exigé une moyenne de 435 répétitions pour l'apprentissage, c'est-à-dire, une répétition entièrement correcte. En comparaison à ceci, les 7 morceaux présentés dans la première enfance et l'en-

fance ont exigé une moyenne de 317 répétitions,—une économie évidente et statistiquement signifiante. En général l'économie a été plus grande pour les morceaux présentes premièrement dans les années plus avancees Cependant, le morceau même qu'on avait lu au sujet à partir des âges de 15 à 18 mois a été appris en 382 répétitions, ce qui montre donc l'evidence de quelque retention de cette première période

BURTT

EINE EXPERIMENTELLE UNTERSUCHUNG DES GEDACHTNISSES IN FRÜHER KINDHEIT

(Referat)

Der Stoff der Untersuchung bestand aus zwanzig-zeiligen Auszugen aus Sophocles' "Oedipus Tyrannus" in der ursprunglichen Griechischen Sprache Einer mannlichen Versuchsperson wurden taglich drei Auszugen vorgelesen Man began als die Versuchsperson 15 Monate alt war und fuhr wahrend 3 Monaten fort Dann wurden die Auszuge durch andere ersetzt, die abermals taglich 3 Monate lang gelesen, und dann abermals durch andere ersetzt wurden. Man verfuhr auf diese Weise bis die Versuchsperson 3 Jahre alt war Die Untersuchung wurde dann unterbrochen bis die Versuchsperson 8½ Jahre alt war In der Untersuchung des Wiederlernens wurde aus jedem Altersniveau je ein Auszug gebraucht Im ganzen wurden 7 Auszuge verwendet. Sie wurden erlernt mit einer modifizierten Vorsagungsmethode (modified prompting method) In derselben Periode erlernte die Versuchsperson drei ahnliche Auszuge die ihr in ihren fruheren Jahren nicht vorgelesen worden waren. Die Anordnung der 10 Auszugen wurde systematisch von Versuch zu Versuch variirt

Bei den drei neuen Auszugen waren im Durchschnitt 435 Wiederholungen zum Erlernen—d h. zu einer vollstandigen richtigen Hersagung—notig Im Vergleich hiermit erforderten die 7 Auszugen die im Sauglingsalter und im Kleinkindesalter dargeboten worden waren im Durchschnitt 317 Wiederholungen Dieser Unterschied stellt ein unverkennbares und statistisch bedeutsames Ersparniss dar. Im Allgemeinen war dass Ersparnis bei den Auszugen die ursprunglich in den relativ-spateren Jahren dargeboten worden waren grosser Sogar der Auszug, jedoch, der der Versuchsperson im Alter von 15 bis 18 Monaten vorgelesen worden war wurde in 382 Wiederholungen erlernt, und wiess also darauf hin, dass selbst aus diesem fruhen Alter etwas behalten wurde

BURTT

THE RETENTION OF COPULATORY ACTIVITY IN MALE RABBITS FOLLOWING CASTRATION*[1]

From the Department of Psychology of Stanford University

CALVIN P STONE

Domestic and laboratory animals castrated after puberty may retain copulatory ability for various periods of time thereafter. This point was clearly brought out for rats by Steinach in 1894 and again by Stone in 1927, yet so few studies of this character have been made that one cannot safely generalize as to the period of time sexual vigor will persist in other castrated mammals The subject is of special importance to investigators who are analyzing dynamic factors underlying sexual activities or measuring the efficacy of testicular transplants, injections, extracts, or other agencies employed therapeutically to augment or restore sexual vigor For this reason the subject deserves further study. It is obvious that one can better evaluate the potency of foreign agencies when their action is clearly differentiated from equivalent influences normally persisting after castration

In a previous report (4) data were presented on the retention of copulatory activity in male rats castrated at the age of three months. Because of the extreme rapidity of copulation in rats and the smallness of organs to be observed, however, great difficulty was encountered in accurately determining whether intromission took place in each instance of the overt response. Hence, in continuing this line of investigation it seemed advisable to observe a larger animal, such as the rabbit, whose copulatory act is such that unequivocal evidence on intromission can be obtained.

ANIMALS, HOUSING, FEEDING

The strains of rabbits employed, their weights, and ages at the time of castration are shown in Table 1 These breeds, with the exception of No. 20, are known to the trade as meat and fur rabbits. They have demonstrated their hardiness and fertility through

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many generations, a consideration of capital importance in a purely commercial venture. Although to have reared all of the animals would have been preferable in a study of this character to insure proper nutritional control, this was not feasible except in the case of the two young groups. The time and expense involved in attempting to rear suitable representatives of the middle-aged and senile groups left no choice but to select suitable specimens from a near-by rabbitry where pedigree records insured accuracy of birth dates and their satisfactory service in the colony as sires assured us of their having been well cared for throughout life.

From a consideration of Table 1 it may be seen that four rather

TABLE 1

THE BREED, AGE, AND BODY WEIGHTS OF RABBITS USED

Body weights were taken at the time of castration

No	*Breed*	*Age at cast*	*Weight at cast*
	Group I, Sexually Immature		
1	Chinchilla X New Zealand White	4.0 mos	7.0 lb
2	New Zealand White	4.0 mos	6.0
	Group II, Sexually Mature, Young		
3	New Zealand White X Himalaya	5.3 mos.	7.5
4	" " " " "	5.3 "	7.0
5	" " " " "	5.3 "	7.5
6	" " " " "	5.3 "	7.5
7	" " " " "	5.3 "	8.0
8	" " " " "	6.0 "	8.0
9	" " " " "	6.0 "	7.5
10	" " " " "	6.0 "	8.5
11	" " " " "	7.3 "	8.5
12	" " " " "	7.3 "	8.5
13	" " " " "	7.3 "	8.5
14	" " " " "	7.3 "	8.0
15	" " " " "	7.7 "	8.0
16	" " " " "	8.0 "	8.3
	Group III, Mid-aged Adults		
17	New Zealand White	2 yrs	8.5
18	Chinchilla	2 "	7.5
19	Silver Fox	2.25 yrs.	8.3
20	Lilac	2 yrs	5.5
21	New Zealand White	3 "	9.3
22	American Blue	3.25 yrs	8.5
	Group IV, Adults Approaching Senility		
23	Chinchilla	4.5 yrs	6.5
24	New Zealand Red	5 "	9.0
25	American Blue	5 "	10.3

distinct physiological epochs are represented by the animals at the time of their castration. In the first group are two individuals castrated while on the threshold of puberty, but which, by virtue of their sexual immaturity, would not attempt copulation Group II consists of post-puberal males which, at the time of castration, were capable of begetting young During the week preceding castration these animals were tested from three to four times in order to assure the experimenter of their sexual aggressiveness No animal was castrated unless he had demonstrated a high degree of sexual aggressiveness and copulatory drive. Group III consists of middle-aged adults which were still in their prime from the standpoint of fertility and sexual vigor. Group IV consisted of animals which, although healthy, sexually active, and fertile, had certainly passed the prime of life. Evidence of locomotor decrepitude was displayed by Nos. 24 and 25 as they moved about the cage.

During the entire experiment the animals were housed in an airy sub-basement where the temperature never became sufficiently warm in summer or cold in winter to cause distress to the animals. Young males were segregated from females a few weeks after weaning and thereafter kept together until homosexual practices and fighting at the age of puberty made it desirable to place them into individual hutches The latter (3'x2'x2') were suitable in size and construction for subsequent tests of copulatory activity

The forage consisted of dry, "green" alfalfa hay, selected particularly for rabbits because of the small stems and luxuriant growth of leaves. To this was added daily a ration of rolled barley and from one to two medium sized carrots per week Occasionally a bit of bran or rolled oats was added to the barley and lettuce or cabbage substituted for the carrots Under this dietary regime males and females are fertile, mothers nurse their young very well, and the latter undergo a rapid course of development (Note the weights of Nos 1, 2, 3, 4, etc.)

Tests for Copulation

Tests for sexual behavior were made under similar conditions for normal control and castrated males and, in all essentials, as this problem is handled by commercial breeders A doe, picked out of the colony on the basis of homosexual behavior or congested, purplish vulva, was tested for receptivity with a normal male, after which, if found receptive, she was placed into the hutch of the

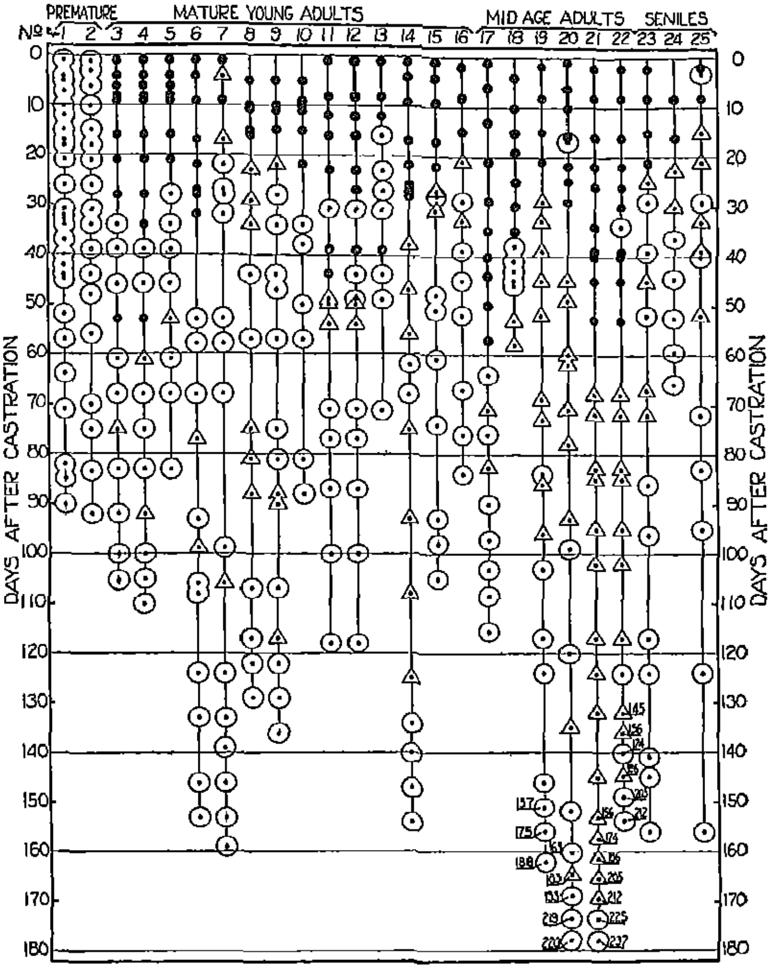

FIGURE 1

THE PERSISTENCE OF COPULATORY ACTIVITY IN MALE RABBITS AFTER CASTRATION

Days after castration are indicated by the scales on the outsides of the figure Each column is a complete record of the test results for an animal Black dots indicate that the animal executed the complete overt copulatory act, triangles indicate mounting and pelvic movements, but no intromission, and the circles indicate that no attempts at mounting were made. In the interest of economy of space the lower portions of the columns for Nos 19, 20, 21, and 22 are condensed The beginning of condensation is indicated by dots connecting the symbols and the placement of numbers beside the symbols to denote elapsed time from castration

castrated male There she was left for approximately 10 minutes, if necessary, but removed at once when the desired evidence of copulation had been obtained After failures to obtain mounting or failures of intromission, trials were repeated once or twice within a half hour on that same day The inter-test intervals varied somewhat for the different animals, as shown in Figure 1, because our colony of females did not always provide a sufficient number of receptive animals at the time they were needed. At no time, however, were tests so spaced or repetitions of copulation so frequent as to render a male impotent by virtue of "over copulation" as judged from observations on normal controls which, under a similar test-regime, remained aggressive throughout the period of the experiment

The Copulatory Act

No alteration of the overt characteristics of the complete copulatory response was noted except the gradual shortening of the period of intromission. The rabbit, it may be recalled, upon making contact between the tip of the penis and the vaginal orifice of the female, throws the pelvis forward with great vigor in a final copulatory embrace. This final embrace, the period of intromission, was gradually shortened in the castrates but not completely eliminated

Post-Castrational Copulation

The results of this experiment are presented graphically in Figure 1. Each column is an epitome of the post-castration, copulatory activity of the animal whose number appears at the top of the column Time scales on the sides of the figure denote elapsed time after castration In the columns, black dots are used to indicate *intromission, triangles to denote mounting and pelvic movements* without intromission, and open circles to indicate no mounting or wholly negative results in the test The place of each symbol with respect to the time scale gives the number of days elapsing between castration and the test

Considering first the two animals castrated prior to puberty, it may be noted that no sexual behavior was elicited from them in any test period although these tests ran well beyond the age of puberty in the normal male of Group II Getting no copulatory behavior from the pre-puberal castrates is in keeping with many similar observations on domestic and laboratory mammals (4) *It would seem*

that the gonads are absolutely necessary for completion of the developmental processes underlying overt expression of the sexual libido.

In marked contrast with the pre-puberal castrates are the pubescent young and fully developed adults, every one of which copulated in the post-castrational tests For No 25 the last intromission elicited was on the 8th day after castration and that of No. 17 was on the 57th day. These cases probably indicate fairly well the minimal and maximal duration of copulatory ability after castration in mature, well-nourished rabbits The average interval from castration to last complete copulatory response by the young adults was 29 days (14 cases); that for the prime adults was 41 days (6 cases), and that for the three senile individuals was 15 days

Although our groups are not sufficiently large or homogeneous as to strain and sexual experience to warrant comparisons of means, it would seem that the short interval of post-castrational copulation of the three old animals is worthy of further comment Observations made on each of the animals prior to their castration showed the least copulatory vigor and persistence in the senile individuals of any of the adults tested This fact suggests that the time interval necessary to drop the copulatory drive below the effective minimum for copulation varies directly with the strength of this drive at the time of castration The point is one for future investigation when suitable quantitative measures of strength of sexual drive in rabbits have been devised

To experimenters concerned with the restoration of sexual libido by therapeutic measures, it is important to note that sexual aggression does not terminate suddenly with the last instance of intromission. Mounting and pelvic movements appear for a variable time thereafter As a rule, however, one notices some diminution in the persistence of mounting and the vigor of pelvic movements after intromissions cease, and finally the mounting attempts can be considered as little more than gestures at copulation, so feeble are the pelvic movements. Outstanding examples of repeated and vigorous efforts at copulation long after the last instance of intromission were provided by adults Nos 21 and 22. Their last complete act occurred 53 days after castration but they continued to mount females approximately 5 months thereafter. When copulatory attempts persist long after castration, equivocal evidence of the potency of orchitic extracts for the restoration of sexual libido must be guarded against

Cause of Failures of Intromission

The copulatory attempts without intromission, to which we have just referred, are not the result of accidental factors to be seen operating now and then in the case of normal animals. Should the female fail to raise the pudendum, failures of intromission are to be expected and do occur regularly because of the inability of the male to reach the vaginal orifice But failures when a receptive female raises the pudendum are primarily due to flaccidity of the organ of intromission or lack of persistence in the piston movements of the pelvis In these respects normal males are seldom found wanting and for that reason stand in marked contrast to the gonadless males tested about one month after castration This point was verified in a fairly satisfactory manner by testing males in a special cage with plate-glass bottom set upon stilts of sufficient height to permit of observation from below It was found that castrated males lacked in persistence of pelvic movements and that, as a rule, erection of penis passed into flaccidity after a few seconds of pelvic movements Even when the pudendum of the female was raised sufficiently for intromission chance contacts between the organ of intromission and the vaginal orifice were not made by the castrate because of insufficient pelvic movement or flaccid penis

May the Indicators of Sexual Drive be Graded?

The persistence of mounting and pelvic movements after failures of erection which prevent the copulatory act from terminating in intromission suggest the desirability of grading our most valid indicators of sexual drive as to their delicacy and severity Almost universally attempts at copulation have been considered valid indicators of sexual libido, the strength of which can be represented by copulatory freqency in a time-limited observation period Likewise, the frequency with which an animal will cross a punishment grill in order to come into the presence of a suitable sexual incentive has been offered as a valid and reliable measure of the strength of the sexual drive (5, "the Obstruction Method"). Still other indicators, such as fighting, locomotor activity in a revolving cage, restlessness, and even morphological signs have served this purpose in one or more investigations Now, it is important for experimenters to consider the question as to whether these indicators are pointing to the same motivational factors, whether they are equally reliable, and whether they may be arranged according to a scale of delicacy and

severity for measuring the sexual drive The fact that rats that did not copulate with very receptive females would undergo punishment to come into the female's presence suggests that the obstruction method is a more delicate indicator of sexual drive than copulation (1, 2) Also, our present findings that intromission disappears in castrated rabbits before mounting and pelvic movements suggests that intromission, as a test of sexual drive, be placed well toward the upper limit of severity. No higher test is known to the present experimenter except one based on frequency of intromission in a time-limited observational period. The problem of forming a graded series of indicators of sexual libido would seem to admit of experimental solution and now should be attempted in view of the great desirability of knowing the most valid and reliable measures of the effects of castration and subsequent restorative therapy

Conclusions

1 Two pre-puberally castrated male rabbits which were tested for approximately two months after the normal age of puberty did not display any evidence of sexual libido as indicated by their mounting of receptive females

2 Twenty-three males castrated after puberty displayed, without exception, the ability to copulate The shortest post-castrational interval for copulation was 8 days and the longest was 57 days. For a group of 14 males castrated between the 5th and the 8th month of age the last act of intromission fell, as an average, on the 29th day after castration, it fell on the 41st day for a group of 6 adults castrated between the ages of 2 and 3 years and on the 15th day for a group of old males castrated at the ages of 4.5 to 5 years Because of the smallness of groups tested, the heterogeneity of breeds used and the diversity of pre-copulatory experience of the groups, age differences are not emphasized except to state that all available evidences point to a lower degree of pre- and post-castrational copulatory drive in the old males.

3 In all but one of the 23 mature males instances of mounting and pelvic movements were observed after the last copulatory act involving intromission It is suggested that failures with respect to intromission resulted primarily from failures of erection and persistence and vigor of pelvic movements on the part of the castrated male The maximum interval for mounting attempts after the last act of intromission was approximately five months

4. The desirability and feasibility of forming a series of behavior indicators of sexual drive properly graded as to delicacy and severity is suggested In the rabbit, intromission is considered to be a more severe test of sexual drive than mounting and pelvic movements.

References

1 Jenkins, M. The effect of segregation on the sex behavior of the white rat as measured by the obstruction method *Genet Psychol Monog.*, 1928, 3, 455-571

2 Nissen, H W The effects of gonadectomy, vasotomy, and injection of placental and orchic extracts on the sex behavior of the white rat *Genet Psychol Monog*, 1929, 5, 451-550

3 Steinach, E Untersuchungen zur vergleichenden Physiologie der mannlichen Geschlechtsorgane *Arch f d. ges Physiol*, 1894, 56, 304-338

4 Stone, C P The retention of copulatory ability in male rats following castration *J Comp Psychol*, 1927, 7, 369-387

5. Warden, C J. Animal motivation studies New York Columbia Univ Press, 1930 Pp 498.

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LA RÉTENTION DE L'ACTIVITÉ COPULATRICE CHEZ LES LAPINS MÂLES APRÈS LA CASTRATION

(Résumé)

Plusieurs expérimentateurs ont montré que les animaux domestiques et ceux employés dans le laboratoire castrés après le puberté retiennent leur pouvoir copulateur pendant divers espaces de temps Dans cette étude-ci on a constaté que les lapins castrés avant la puberté n'ont pas développé assez de libido sexuel pour causer des essais de copulation avec des femelles réceptives Vingt-trois mâles, castrés après la puberté, ont montré une capacité de copuler, sans exception, pendant divers espaces de temps après. Quatorze mâles castrés entre l'âge de cinq mois et de huit mois ont accompli le dernier acte d'intromission, en moyenne, le 29me jour après la castration Pour un groupe de 6 adultes de moyen âge castrés entre les âges de 2 ans et de 3 ans cela est arrivé le 41me jour, et pour un groupe de trois vieux mâles castrés aux âges de 4,5 à 5 ans, le 15me jour après la castration Quoique l'on ne doive pas trop appuyer sur les différences entre de petits groupes d'animaux, il paraît que les adultes en pleine maturité dans la fleur de leur vie reproductrice lesquels ont eu beaucoup d'expérience copulatrice retiennent pendant le plus de temps leur libido sexuel, comme le manifestent des actes copulateurs complets Les mâles séniles, quoique fertiles, ont montré relativement un petit degré de vigueur sexuelle dans les tests avant et après la castration

Il est important de noter que les efforts de monter sur la femelle et les mouvements pelviens ont persisté pendant un espace de temps variable après

le dernier acte d'intromission. Ce sont un critère moins sévère du libido sexuel, croit-on, que l'intromission L'auteur montre qu'il est préferable de classer comme doux ou sévère une série de critères de vigueur sexuelle chez les animaux du laboratoire Un tel classement pourrait être d'une grande valeur pour les expérimentateurs qui étudient la puissance des extraits orchitiques

STONE

DIE BEIBEHALTUNG DER BEGATTUNGSTATIGKEIT NACH KASTRIERUNG BEI MANNLICHEN KANINCHEN

(Referat)

Wie von verschiedenen Forschern schon erwiesen worden ist, behalten nach der Pubertat kastrierte Haus und Versuchstiere ihre Begattungsfahigkeit wahrend verschiedener Zeitraume noch bei In der gegenwartigen Untersuchung zeigte es sich, dass vor der Pubertat kastrierte Kaninchen nicht genugenden sexuellen Libido entwickelten um zu Begattungsversuchen mit empfanglichen weiblichen Tieren erregt zu werden Dreiundzwanzig post-pubertal kastrierte Kaninchen offenbarten ohne Ausnahme noch wahrend verschiedener Zeitraume Begattungsfahigkeit Vierzehn mannliche Tiere die zwischen dem 5 ten und 8 ten Lebensmonat kastriert worden waren vollzogen den letzten vollkommenen Begattungsakt (intromission) im Durchschnitt am 29 ten Tag nach der Kastrierung Bei einer Gruppe von sechs Tieren auf dem Lebenshohepunkt die im Alter von 2 bis 3 Jahren kastriert worden waren wurde dieser letzte Akt im Durchschnitt am 41 sten Tag und bei einer Gruppe bestehend aus 3 alten mannlichen Tieren die im Alter von 4 5 und 5 Jahren kastriert worden waren, am 15 ten Tag nach der Kastrierung ausgefuhrt Obwohl auf Unterschiede zwischen kleinen Gruppen von Tieren nicht zu viel Gewicht gelegt werden darf, scheint es doch, dass die vollig reifen erwachsenen Tiere die auf dem Hohepunkt ihres reproduktiven Lebens stehen und die in der Begattung viel Erfahrung gehabt haben am langsten ihren sexuellen Libido beibehalten, wie er sich in vollstandigen Begattungsakten darstellt. Die senilen mannlichen Tiere, obwohl sie fruchtbar blieben, zeigten einen relativ niedrigeren Grad der sexuellen Rustigkeit sowohl in den Proben die vor wie in denen die nach der Kastrierung stattfanden

Wichtig ist die Bemerkung, dass die Bewegungen des Besteigens und die Beckenbewegungen noch eine Zeitlang nach dem letzten Intromissionsakt bestanden Diese Bewegungen stellen scheinbar in weniger strenges Kriterium des sexuellen Libido dar, als die Intromission Der Verfasser weist darauf hin, dass es wunschenswert ware, eine Kriterienserie der sexuellen Rustigkeit (vigor) bei Versuchstieren aufzustellen. Eine solche Rangierung der Kriterien von "mild" bis "streng" konnte fur Forscher die an der Kraft orchitischer Extrakte arbeiten unschatzbar sein

STONE

A STUDY OF THE CRYING OF INFANTS DURING MENTAL AND PHYSICAL TESTS*

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The affective behavior of infants, in its relation to a theory of emotions, was first studied experimentally by Watson (24). His widely quoted results suggest that emotional responses occur in definite reflex patterns, that these patterns are limited in number ("fear," "rage," and "love"), and that they are aroused by a limited number of stimuli. Subsequent studies, especially those of Blanton (2) and Sherman (21), have resulted in changes in the inventory of provocative stimuli, and have also tended to break down the concept of specific, differentiated emotional patterns.

In the light of this later evidence, the classification of the affective behavior of neonates has been simplified to include only positive and negative reactions, or undifferentiated pleasure and undifferentiated distress (21, 4). The former is the accompaniment of physical well-being, stroking, rhythmic motion, and the like; the latter may be elicited by bodily discomfort or pain (internal, such as colic and hunger, or external, noxious stimuli) and various abrupt changes in the environment, such as a loud noise, a shake, or loss of support. With age, differentiation of response develops and the range of stimuli which will elicit emotional responses increases. Buhler (6) points this out, with illustrations from infants observed in their normal environment during the first year. A good theoretical statement of developmental changes is given by Bridges (4) in a recent article.

In the first months of life the easily observable signs of emotional response are facial expression, activity, vocalizations (cooing and scolding), and crying. Variations in emotional activity may be described in terms of the motor elements involved in the response, in terms of the positive or negative adjustment to the stimulus, or in terms of variation in intensity and duration.

Watson has contended that all emotional responses to other than

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the original stimuli are the outcome of conditioning, and has given illustrations of conditioning through the association of effective and indifferent stimuli (24). In a series of experiments with children from three months to nursery school age, H. E Jones (13, 13*a*) has brought about changes in overt emotional reactions, and in visceral reactions as registered in the galvanic skin reflex, which conform to the phenomena of conditioning and of inhibition described by Pavlov But in their experiments on age differences in fear reactions to animals, H E. and M C Jones (14) have indicated that stimuli may acquire emotional significance through processes of general maturation, and without specific conditioning. It appears, then, that the development of emotions cannot be described in any single formula, but involves changes which are dependent upon general growth, and changes based upon conditioning, and, no doubt, upon other forms of learning as well

Recent investigators give conflicting reports concerning the specificity of emotional response and emotional periodicity Some hold that there is a general trait of emotionality, which is augmented periodically at certain stages in the development, subsiding in the intervals between Others believe that there are no evidences of periodicity, and some have pointed out that emotional reactions depend on specific stimulation rather than on a general underlying affective tendency

A brief review of the experimental literature which has some bearing on the periodicity of emotions illustrates this disagreement. Among the experiments indicating such tendencies, the youngest is reported by Lippman (20). Of 178 infants who were observed in their reactions to toys, 42 cried after the test period had started, and among these the greatest incidence of crying was between 6½ and 10 months Lippman does not, however, offer any theory in explanation of this, but merely lists the causes of the crying

Levy and Tulchin (19), in a study of the resistant behavior of 982 children from 6 to 54 months of age during a Kuhlman-Binet mental test, conclude that "The manifestation of resistance by infants and children during mental tests is evidence of some innate behavior pattern It is typically pronounced at 18 and 23 months in females, and at 30 to 35 months in males It yields gradually with age in both sexes" Keens and Blatz (17), in observations of preschool children, have reported a "tendency to greater frequency of emotional episodes in the three-year-old children." Blatz and Bott

(3), in a tabulation of misdemeanors in school children, taken from weekly reports by their teachers, found a greater number throughout for boys, and among boys, found a greater frequency at the ages 8 to 9 years, and an inverse relationship with IQ. Busemann (7), reviewing the literature, concludes that periods of emotional excitation appear at the ages of 3, 6, 9, 12 or 13, and 16 or 17 Eng (8), in comparing a group of eleven-year-old children with young adults (20 years), found a relatively greater number of spontaneous displeasure responses in the adults, and, conversely, a greater number of spontaneous pleasure responses in children. The reactions to the test stimuli showed no differences.

It has been frequently assumed that there is an emotional crisis at adolescence. Buhler (5) and Hetzer (12), according to Jones (15), "have reported a prepubertal 'negative' phase." G S Hall (10, p 74) in *Adolescence,* although he gives no experimental evidence to support it, voices a prevalent belief. He says· "The teens are emotionally unstable and pathic. It is the age of natural inebriation without the need of intoxicants . . . characterized by emotionalism."

On the other hand, Hall's study of fears (9) indicates only slight gradual changes with age, in boys an increase from 7 to 15 years with a subsequent decline, but in girls a steady increase through 18 years. Other studies have also failed to obtain age differences in emotionality Lehman and Witty (18), in their play quiz given to 6000 children in Grades 3 to 12, found no evidence of periodicity in play interests, but large individual differences at every age that greatly outweighed any slight changes from one year to the next This was true both of specific play interests, and of social as related to solitary play Though this study is not directly concerned with emotions, any marked periodicity in play interests would no doubt be associated with emotional variations. Blanchard (1) classified the dreams of 189 clinic children according to their motivation and frequency of occurrence She found no significant age differences in either M C. Jones (16) has found that the number of fears of children aged 3 months to 7 years apparently increases with age as a result of increased insight into unusual situations, and of conditioning Washburn (23) concludes from her study of smiling and laughing in infants· "Following its appearance, the incidence of smiling and laughing is not a correlate of chronological age, relative rate of mental development, nor physical condition as evidenced by the weight-height index." Stutsman (22) found that in her tests

on 631 children between the ages of 18 and 77 months the resistant behavior was more frequent toward certain tests which tended to makes the child self-conscious. Greater frequency of this type of test in the lower levels caused more refusals in the younger children than in the older ones whose tasks were more objective

If we group together the various studies which indicate periodicity, we see evidence of increased emotional reaction of one kind or another at the ages 6½ to 10 months, 18 to 35 months, 3 years, 6 years, 9 years, 12 or 13 years, 15 years, 16 or 17, and 18 years If we accept uncritically all of the data indicating periods of greater emotion, we must assume a very rapid fluctuation at first, and a continuously increased emotivity from 15 years on When we consider that these studies are made with a variety of situations and of emotional responses, and that other careful studies have failed to show periodic fluctuations, it seems probable that a further analysis of emotional development will show these variations to be only apparent.

Studies of the emotional reactions of adults (25) point to specificity of response rather than to a general factor of "emotionality" If this is true, we might expect to find a similar type of organization in children also, and the amount of emotional response, and the nature of the adequate stimuli would vary with learning, and with the stages of mental growth. For example, it is possible that children react negativistically to certain things at a certain stage in their development because at an earlier stage they are not sufficiently mature to comprehend the difficulties in the situations, or to feel independent enough to revolt against adult authority. When they *do* reach this stage, "negativism" usually appears, while at a later age they have advanced beyond the need of an emotional response—through the effects of habit and familiarity, or through greater ability to cope with a complex situation In this way emotional behavior of some form or other may appear frequently throughout the whole developmental period as more complex problems are discerned, and die out again as the individual learns to cope with each new problem.

The hypothesis may be advanced that all apparent periodicity in emotional development is due to the overlapping of various causes of emotional response, which operate more or less independently of each other, their effectiveness depending upon the stage of maturity of the individual and upon specific conditioning This interpretation is justified, I think, on the basis of the present study of the rela-

tive amount and the causes of crying during the first year of life. Although this covers only a single year, it is the year of most rapid change and development of the individual, and an analysis of the variations in causes of emotions with age, at a time when comparatively little opportunity for conditioning has occurred, may give an indication of the direction of emotional changes later.

The Present Study

The infant survey of which this paper treats in part was undertaken with the purpose of obtaining a developmental picture of a group of 61 infants (31 males and 30 females), studied with reference to a comprehensive schedule of physical and mental traits The children were all of white, English-speaking parentage A preliminary comparison with the Heilman revision of the Chapman-Sims scale (11) shows the group to be comparatively homogeneous, and selected from the middle classes with none of extremely high or low socio-economic status. The observations were made at the hospital during the first three days of life, and thereafter once a month at the Institute for a period of approximately an hour. Each child was brought in by appointment, on or near his birthday, and, in so far as possible, at a time of day when he was most likely to be awake and playing The mother usually came with the child and was present during the entire period. The tests were made by the writer and by a pediatrician (Dr. Lotta Wolff) In addition, there was usually a recorder (Miss H E Neall) in the room, who sat at a table and wrote down the reports of the experimenters, and made a running account of the baby's behavior and also of significant features in the mother's reactions

The program during this observation period consisted of tests of mental and motor development, reflexes, some physiological measures, anthropometric measures, and (on alternate months) photographs. Moving pictures were taken, at longer intervals during the early months, and later, with the beginning of locomotion, every month[1]

As a result of this schedule the child was confronted by a great many unusual stimuli, and received considerable handling by people

[1]In addition to these data the program included a socio-economic history taken by a social worker who made home visits, prenatal and neonatal data, x-rays, and immunity tests At three-month intervals, information was obtained about diet, sleep and elimination habits, and exposure to fresh air and sunshine. Records of dentition and illnesses were also kept

to whom he was unaccustomed. For the sake of getting accurate and complete records, and maintaining optimum cooperation, every attempt was made to keep the child happy But, in spite of this, the situation was exciting and in many cases disturbing to him During the observations at the Institute, it soon became evident that there were wide variations in the degree of disturbance of these infants as indicated by such objective signs as are easily observable One such sign of emotional upset, crying, we have regarded as a fairly valid measure of the child's emotionality because, in the newborn infant, it is usually a symptom of distress, and because it remains a predominant means of registering discomfort or annoyance throughout the first year of life It seemed advisable to keep a record of this crying in regard both to its effect on the tests made, and as a measure of differences in affective behavior of the children.

Such a test situation as this offers a number of advantages in the observation of emotional reactions. First, a wide variety of stimuli were presented, allowing for observation of behavior under varied conditions Another concomitant of this method is the range in intensity of the emotions elicited. In a test devised expressly for observation of emotional behavior, it is necessary to limit oneself to emotions of slight intensity in order to maintain cooperation through a series of visits. But when physical tests are being made, the mother is more inclined to accept them as necessary, even though the child cries lustily In this way we have obtained records of an unusually wide range of intensity as compared with most experimental studies Again, the cumulative material on the same children makes possible the study of individual affective tendencies It also eliminates the possibility of apparent fluctuations being due to variations in the sample. Finally, since practically the same stimuli were repeated each month, the children's reactions to the same things at different ages could be compared

On the other hand, there are some definite limitations which must be taken into account The fact that this material was secondary to our main purpose often resulted in variation of the conditions in order to get the best possible records in other things The effect of this variation was to shorten the crying time of the more excitable infants as compared with the calmer ones These differences in treatment were unavoidable, as it was important to obtain most of the reactions and test measures while the child was in a quiet, happy mood, and it was important to have the continued cooperation of

both mother and child for repeated visits Cases in which either a mother or child was high-strung, or easily disturbed, demanded more cautious handling, and occasionally even the omission of some of the tests seemed expedient.

A brief description of the procedure followed will give an idea of the situations to which the child was submitted. The order of giving the tests was not invariable (depending on a child's particular dislikes, and on his age), but as a rule they occurred in the following sequence

Mental test (unless child was asleep or drowsy)
Undressing
Physiological tests
Skin reflexes
Photographs
Motor tests
Anthropometric measurements (except length)
Postural reflexes
Weight and length
Dressing

This order placed first the things which were least disturbing and the things which it was more important to measure while the child was quiet. The tests were given to the young infants in a crib or on a canvas table, later, in the mother's lap, and, in the last three *or four months, in a high chair before a table, and on the creeping* path

The mental test period was usually a happy one of playing with toys, although occasionally some crying occurred if, for example, an attractive toy was removed while the child was still interested in it. The reflex responses were elicited by tapping or stroking the child at certain body points, and by placing him in certain positions Adequate stimulation of the so-called postural reflexes—such as resistance to head turning, nystagmus and "jump pattern"—tended to provoke crying, especially in the older ages The physiological measures—pulse rate, breathing rate, blood pressure and temperature —did not, as a rule, cause crying until the second half year,[2] when

[2]The primary differentiating factor here seemed to be that not until about this age did the children discriminate between a familiar situation and one in which there were strange persons and instruments to which the child was not adequately adjusted Such a situation, when it was discriminated, tended to induce a sense of confusion and insecurity, manifested

all but the breathing count became potential cry-producing stimuli When locomotion began, creeping and walking were tested on a "creeping path" covered with a long strip of muslin and brilliantly illuminated by motion picture lights The locomotion itself, of course, would not cause crying, but the conditions under which it was observed—being separated from mother, the bright lights, and the noise of the camera—were frequently upsetting, especially to the child who was not accustomed to being taken about to strange places. The most annoying of the anthropometric measures were length, weight, and the head measurements, any of the other measurements were also common sources of crying, because they involved some confinement of movements, and, later, because the instruments were strange to the child.

Schedule E, which is herewith reproduced, was used for a descriptive record of the affective behavior of the child during the test situation All conditions which might be of emotional significance, as well as the emotional responses themselves, were recorded on this form. The time of day at which the test was given and the time of the next nursing of the child were recorded These, with the wakefulness checked in 5, and special notes on physical conditions, formed a basis for working out relationships of crying to the testing situations themselves Under *Situations which result in crying* were listed all of the conditions during which crying occurred, specific stimuli involved in the test situations, or evidences of internal or other exciting conditions After each situation the continuity and intensity of the cry as judged by the recorder was noted by code letters. These letters are given with their descriptive terms under *Nature of cry*, where the ones which most nearly described the crying for the entire period were encircled The total duration of crying was measured on a cumulative stop-watch and the total examination time recorded. From these the percentage of the period during which the child cried was computed

Situations which inhibited the crying were listed and described, with a brief note indicating their comparative efficacy Situations which resulted in positive responses of smiling, cooing, etc., were

objectively in fear responses and crying In addition to these responses to what might be called the emotional potentialities of the situation, there is the fact of increase in general motor activity with age, so that those tests which involve a limitation of bodily movements over a continued period (as counting pulse) are actually more confining to the older children, and consequently meet with greater resistance and provoke more crying

SCHEDULE E

Name of child Date Age Case No

Observer Time (1) (2) Time of next nursing

1. Situations which result in crying

2. Nature of cry
   - 0 Continuity (a) intermittent (b) (c) very persistent
   - 1 Intensity (x) slight whimpering (y) (z) violent crying
   - 2 Total duration of crying 3 Total examination time
   - 4 Procedures omitted because of crying

3 Situations which inhibit crying (picking up, auditory stimuli, etc)

4 Situations which result in positive responses of smiling, cooing, etc

5 Wakefulness	Sound sleep	Drowsy	Awake	Lively
0 On arrival				
1 On departure				
2 Ordinarily at this time (M's report)				

	1	2	3	4	5	6	7
6 Degree of "strangeness" Shy—unreserved							
7 Activity Inactive—vigorous							
8 Speed of movements Slow—rapid							
9 Responsiveness							
0 To toys Slight—marked							
1 To persons Slight—marked							
10 Amount of positive behavior Negative—positive							
11 Irritability Excitable—calm							
12 Emotional tone Happy—unhappy							
Description of M's reactions							

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described, with the responses which were made in each situation and an estimate of their amount The observer checked, also, on a four-point scale, the wakefulness of the child as indicated in his behavior on arrival and on departure, and the mother's report of his usual behavior at this hour when at home

From the records thus obtained, with a minimum of interpretation, we hoped to form a classification of the causes of crying which would be free from preconceived notions. We soon found that the crying often appeared to be due to other than the conditions of the experiment as such, and we felt that we could judge from the attendant circumstances what these causes were. These developed into a group of about ten factors which occurred repeatedly, so that it was possible to give each an exact description and to assign to them code letters for greater ease of recording. As a new or unusual cause which failed to fit any of these categories was noticed, it was described on the record, and if it was repeated several times, a code designation was given it also. There were 13 causes of crying thus identified during the year. At the close of each examination period the experimenters reviewed the situations under which the child cried, and reached a decision as to which of these causes were instrumental. These were then entered on the schedule in the order of their importance Since each experimenter was attending to the child's behavior at different times during the hour, the letters were assigned on the basis of a combined judgment after discussion. We took pains to make the judgments as objective as the conditions permitted, especially in regard to possible differences in attitude toward the children at different ages. Our judgments were based on (*a*) the situation, (*b*) the nature and continuity of the cry with its accompanying behavior, and (*c*) its inhibition The 13 causes may be described as follows

Specific test situations Crying in response to specific test situations occurred when the stimulus was applied, was frequently accompanied by struggling, and stopped soon after the stimulus was discontinued.

Continued handling During the testing of the reflexes and measurements, crying started after handling was begun, and continued as long as handling continued, whatever the stimulus.

Fatigue at the end of the test "Fatigue crying" started near the end of the period, and continued during dressing, and was often accompanied by yawning, rubbing the eyes, or drooping

Internal conditions. This refers to any physical condition of the child which seemed to cause him to be in pain or discomfort, i.e., slight illness, temperature, or a cold. We differentiated from this *Colic pain,* which was judged by its continuity, recurrence, and relief when gas was expelled; *Sleepiness,* as expressed in drooping of head, rubbing of eyes, and a tendency to fall asleep when left alone; and *Hunger,* judged by the recurrence of the cry, the lapse of time since the last feeding, by a tendency to suck available objects, and by the cessation of crying after feeding

Strangeness of the place and persons When a child is old enough to make such differentiations, strange persons and place—if he is not taken about frequently—are a definite stimulus for crying This usually occurred when the child was first brought in, or when he was taken from his mother for some of the tests It was also evidenced by clinging to the mother and turning away from the experimenter. Crying from this cause stopped when the child became accustomed to the place, and when held by, or allowed to remain close to, his mother.

Being put down. Between two and six months the child appears to enjoy being held and being in an upright position, though still unable to pull himself to sitting. He not infrequently cries when laid down. This crying could be stopped by picking up the child or propping him in a sitting position

Interference with play activities. If a child was doing something happily, and an adult interfered, he sometimes cried, struggled, and indicated in other ways his desire to return to the interrupted activity

Postural discomfort. This occurred rarely, and in a few infants who seemed always to cry when put in certain positions—the outstanding example was to being laid prone

The last two causes in the list differ from the others in that they are definitely learned or "conditioned" They are:

"Spoiled" behavior. This was evidenced in the child's persistence in crying to gain his ends, or in the readiness with which the mother acceded to his cry, and by the lack of physiological evidence of disturbance—blood pressure and pulse rate remaining normal

Adverse conditioning. It was found that in certain cases, when a child was old enough to remember something from one visit to the next, he cried at first sight of the experimenter, though he had not cried at sight of other strangers; or he cried at the end of the mental

tests when his chair was turned toward the mother so she could undress him, or on the first sight of some instrument before the child was closely approached or touched with it This seemed to be a definitely conditioned displeasure response to certain situations

These classifications are necessarily subjective, and it was often difficult to determine what were the effective causes[3] It was also true that, if a child cried continuously for a long period due to such things as *continued handling* or *colic*, this would obscure possible crying due to more specific things such as the *test situations* or *postural discomfort* In such cases, only the predominant cause was, of necessity, recorded. Since in our further treatment of this material we are concerned primarily with group averages, the problem of the reliability of classification is less serious than if we were dealing with individual differences.

Results

The occurrence of these different causes, the nature, and the amount of crying at each month for the group of 61 infants, were tabulated. From these we may discover any tendencies in the unpleasant emotions, as expressed by crying during the examination period

In considering the nature of the cry, the judged continuity of crying which was characteristic of each child at each period was compared with the judged intensity These were tabulated for each month separately, but since there were no age differences in the relations of these two factors to each other, we have combined the tabulations for the entire twelve-month period This table (Table 1) indicates the relationship between the intensity or vehemence of crying, and its continuity or persistence It will be seen at a glance that the vehement crying is almost always persistent, the slight whimper is intermittent, while moderate crying has an average

[3]It is interesting to compare our classification with Buhler's (6) Although our data were taken under different conditions from hers, we find the same fundamental causes operating, so that both lists include many of the same items, through differences in interpretation have caused the division lines to be made differently in the causes which are more complex or depend upon more subjective judgments Thus, where she has *fear*, and *social influences*, we have *adverse conditioning*, *"spoiling,"* and *strangeness of place and persons*. Other differences are due to the observational conditions, i e, we made every effort to eliminate strong sensory stimuli from our experiments, and the child was not observed in sleep, while, on the other hand, the conditions of our experiment made necessary long continued handling by persons with whom the child was not familiar

TABLE 1
THE INTENSITY OF CRYING IN RELATION TO ITS PERSISTENCE

		Vehemence		
Persistence	Slight whimpering	Moderate	Violent	Total
Very persistent	4	85	204	293
Average	33	203	21	257
Intermittent	189	74	11	274
Total	226	362	236	824
No crying				41

degree of continuity, though it is much more varied in its persistence than either the vehement cry or the whimper Since the persistence of crying is indicated more objectively in the total crying time, which lends itself more readily to statistical treatment, only the latter will be treated in further detail This preliminary treatment has shown, however, that as a rule, throughout the first year, long crying time is indicative of more vehement crying and hence greater emotional disturbance.

Since there were no significant sex differences in either amount or causes of crying, the sexes have not been separated in the data presented in this paper.

The percentage of the total examination period that each child cried at each visit was computed. The median percentage[4] of crying for each month is given in Table 2 Since on the odd months pictures were taken, necessitating a greater amount of handling and additional unusual cricumstances, there was a tendency for more crying at these ages The frequency distributions of the percentage of crying during tests which included photographs and those which did not show for the latter a greater predominance of cases with less than 5% of crying. As for the general trend of the figures, there is evidence of a tendency for the amount of crying to become progressively less until the child is about four months and then to increase again, especially after six months The long crying times grow less frequent with advanced age, but with a slight increase again toward the end of the year The periods with less than 5% of crying follow in general the trend of the medians

The differences in amount of crying are evidently not all due to

[4]The median was used here instead of the mean because the distribution was skewed toward the longer crying intervals, making the mean spuriously high as a picture of central tendency

TABLE 2

PERCENTAGE OF CRYING IN RELATION TO AGE AND TAKING OF PHOTOGRAPHS

Month	Median P*	Median N*	Over 35% P	Over 35% N	Less than 5% P	Less than 5% N
1	20.00		41.7		16.7	
2		12.86		14.0		28.0
3	17.50		25.4		17.9	
4		9.64		11.8		38.9
5	15.71		15.5		27.5	
6		12.50		8.7		31.0
7	18.57		15.3		23.0	
8		11.56		15.0		39.6
9	15.00		16.6		18.5	
10		17.08		12.5		19.6
11		17.86		11.5		23.0
12	16.25		22.6		15.0	
Mean	21.64	17.19				
Median	17.05	13.78				
S.D.	18.29	15.21				

FREQUENCY DISTRIBUTIONS OF PERCENTAGE OF CRYING DURING PICTURE-TAKING MONTHS AND NON-PICTURE-TAKING MONTHS

	Percentage of crying 0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89
P*	62	42	37	33	27	17	24	26	8	7	6	6	3	4	1	3	2	1
N*	99	37	37	38	26	28	22	16	8	5	4	4	1	–	–	2	1	–

*P stands for months in which pictures were taken, N for months in which pictures were not taken

these two kinds of experimental situations There seems to be a definite shift in the duration of crying, which might be taken as indicative of periodicity, showing greater emotionality during the first month, and, again, from seven months till near the end of the year. However, the reasons for these trends are probably to be found in a study of the various causes of crying, especially their relative frequency at succeeding ages, rather than in any cyclical change in "general emotionality."

All causes of crying attributed to each child at each age were tabulated The five most frequent causes are represented graphically in Figure 1 From this and Table 3 it may be seen that specific test situations (*a*) were the most frequent cause at all ages. These con-

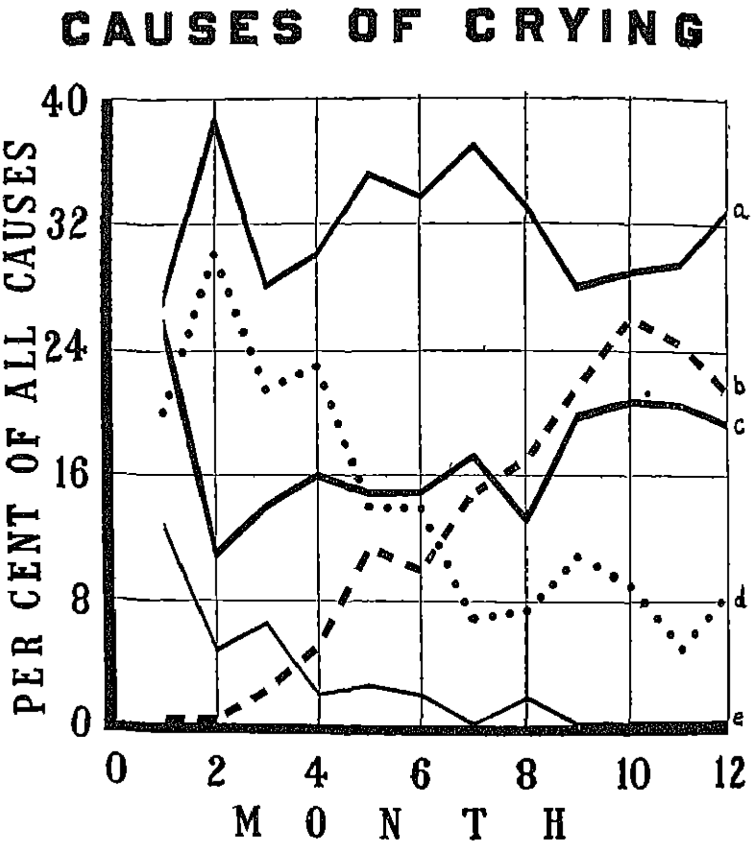

FIGURE 1

sisted largely in restrictions of the infant's movements, handling him, and often changing his position to an unaccustomed one They are shown here to be consistently effective annoyers to a large proportion of the infants throughout the first year of life Although these specific test situations were by far the most frequent causes of crying, they were usually associated with very short periods of crying, since the child stopped as soon as the stimulus was removed. In the early months, fatigue at the end of the test (*d*) was one of the most frequent causes, but, as the children grew older, its importance diminished fairly rapidly. A less frequent cause with the same trend was

TABLE 3
THE RELATIVE OCCURRENCE OF THE CAUSES OF CRYING AT EACH MONTH
(Percentage of All Causes)

	Month											
Causes	1	2	3	4	5	6	7	8	9	10	11	12
Specific test situations	27.3	38.6	28.0	30.0	35.1	33.7	36.8	33.0	27.9	28.8	29.4	33.0
Handling	25.5	10.8	14.0	16.0	14.9	14.9	17.2	13.2	19.8	20.7	20.6	19.4
Fatigue	20.0	30.1	21.5	23.0	14.0	13.9	6.9	7.5	10.8	9.0	4.9	8.7
Internal conditions	5.5	3.6	4.3	0.0	3.5	2.0	6.9	5.7	3.6	1.8	3.9	1.0
Colic	12.7	4.8	6.5	2.0	2.6	2.0	0.0	1.9	0.0	0.0	0.0	0.0
Sleepiness	1.8	1.2	2.2	4.0	7.0	4.0	4.6	7.5	8.1	6.3	5.9	2.9
Hunger	3.6	2.4	5.4	9.0	2.6	3.0	2.3	2.8	0.9	0.9	2.0	3.9
Strangeness	0.0	0.0	2.2	5.0	11.4	9.9	14.9	17.0	21.6	26.1	24.5	21.4
"Spoiled"	3.6	4.8	5.4	6.0	5.3	7.9	9.2	9.4	5.4	3.6	5.9	6.8
Put down	0.0	1.2	7.5	3.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
Interference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
Postural discomfort	0.0	2.4	3.2	2.0	3.5	5.0	1.1	1.9	1.8	1.8	1.0	0.0
Adverse conditioning	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.0	1.9

colic (*e*). When it occurred in a record, it was of importance because it was in general associated with long crying time. Continued handling (*c*), though frequent as a cause during the first month, dropped abruptly in its position at the second month, and then gradually increased during the rest of the year. The drop at two months is, perhaps, indicative of the infants' better adjustment to an environment in which handling occurs. The later increase is probably related (because of its departure from usual home treatment) to a still more marked increase with age of another cause of crying, namely, the strangeness of place and persons (*b*) These last two causes together make up a large proportion of the crying during the second half year.

The other causes of crying, which, due to their infrequent occurrence, have not been represented graphically, with few exceptions show a fairly even spread throughout Two causes, *spoiled* behavior and *sleepiness*, show some increase during the middle of the one-year period. The latter is probably due to a change of the child's eating and sleeping schedule, combined with the mother's failure to change the appointment at the Institute to a more suitable time of day. The *spoiled* behavior curve may be of some significance in keeping the medians as high as they are in months four to eight. Why it

should diminish as soon as it does is largely a matter of conjecture, but this test situation is probably not adequate to obtain a true picture of this type of behavior. Temper at *interference*, and *adverse conditioning* appear only in the last two and three months, respectively The latter shows evidence of the beginning of a curve whose frequency will probably increase considerably during the next few months.

The graphs in Figure 1 indicate the reasons for the apparent decrease in emotionality at the middle of the year They show that the crying is made up of reactions to a number of unlike causes, some of which become less effective with maturation, while others become increasingly effective The result is that though these causes overlap there is a period at about six months in which they are all comparatively infrequent. All, that is, except the specific test situations, which are associated with crying times of short duration, and which show no tendency to change in frequency during the entire age range.

What may appear on the surface as periodicity in general emotionality, turns out on closer analysis to be the resultant of various factors When the total crying time during this particular experimental procedure is considered, there would appear to be slightly less "emotionality" between four and seven months. But if crying for any one of the causes is taken alone, the period of greatest emotionality may shift to almost any month, depending on the cause chosen In the only other study covering a similar age range, with which the writer is familiar, Lippman (20) agrees with the present results in reporting an increased amount of crying between 6½ and 10 months But it is evident that in any similar investigation a change in the trend could probably be produced if the experimental program were altered so as to present a different distribution of the provocative factors. *The apparent periodicity in emotional disposition is best interpreted as due to the combined effect of many specific emotional tendencies, each of which has its own period of waxing and waning, dependent on the complexity of the inciting situation in relation to the individual's ability to establish an adequate adjustment.*

Up to this point, the analysis of periodicity has been in terms of group averages. It is, of course, possible that individual infants may have fluctuations in general emotional level which are dependent upon individual factors in their development, rather than upon any

TABLE 4
INTERCORRELATIONS BETWEEN THE CRYING INDICES AT DIFFERENT AGES

		Mean index for months			
		1-3	4-6	7-9	10-12
Mean index for months	1-3		+ 38	+ 22	+ 15
	4-6		.	+ 26	+.18
	7-9				+ 66

general principles of emotional maturation Such reactions could be studied by systematic daily observation, but would hardly be detected by the present method of monthly testing

It was the general impression of the experimenters that there was little change in any given child's affective disposition from month to month, that certain babies were nearly always calm, "good" babies, while others were high-strung and difficult to approach, it was characteristic of many that they usually cried somewhat, but could be easily comforted. Since the other objectives of the investigation made it advisable to prevent the high extremes of crying time (the high-strung babies being handled with greater caution), it has been pointed out that the situations were by no means identical for every child, nor for the same child at different ages Correlations were computed between the average percentage of crying ("crying indices") for the four three-month intervals as shown in Table 4 Since the correlations computed in the same way for two-month intervals are not significantly different, they have not been included. The coefficients of correlation between consecutive quarter years are the highest, being $38 \pm .082$, $.26 \pm 05$, and 66 ± 054, respectively. There is, therefore, in spite of the invalidating factors mentioned, some positive relation between adjacent periods, especially in the last half year. Over longer intervals the relation decreases, showing the consistency to hold only over short developmental periods. The low correlations at first may to some extent be due to a lack of emotional consistency, but they probably depend more on the greater rôle of variable internal as compared with external stimuli during the first six months. On the basis of the present evidence, it is, of course, impossible to state what factor or group of factors are responsible for the degree of consistency shown It may be that the relatively higher correlation between the last two quarter years is due to a cumulative effect of early emotional condi-

tioning, as expressed in the development of characteristic attitudes toward the test environment Or it may be that a more stabilized emotional level is beginning to emerge, as a result of the inhibition of deviate tendencies. These and other considerations deserve to be treated in more intensive studies of children under daily observation.

A cursory review of the original data sheets corroborates the impression that there is some consistency in the causes which elicit crying in any given child. The child who is strange continues to be so over a period of months, it is always the same few children who dislike being laid prone; it is the same children who from one month to the next are "spoiled," etc For example, Case 26 never cried because of the strange situation, while Cases 32 and 46 both cried from this cause, at seven consecutive visits For five visits Case 2 cried whenever laid prone. Similar instances of the repeated effectiveness of certain causes could be given in the case of the majority of the children.

A number of other possible factors, for which data were available, were found to have no effect on the crying. The mental test scores and the percentage of crying, for the entire twelve-month period, correlate —.098. The correlations for the individual months are similarly close to zero Since crying because of the strangeness of the situation is probably dependent on mental development, a coefficient of correlation was computed between the age of first crying for this cause, and the average sigma score in the mental tests for the three months closest to its appearance. The correlation, —.12, is, again, of no significance. The relation of this cause to mental development is probably obscured by variations in training and in the home environment, for the *discrimination* of strangers is definitely related to mental maturity. No relationships were found between the amount or the causes of crying and sex, birth order, birth weight, or socio-economic ratings [Heilman revision of the Chapman-Sims scale (11)]. It is possible that a definite relation might be found with health, and with the affective attitudes of the parents In further studies of our data we hope to compare the crying with other negative responses and with positive responses, with other measures of emotionality, and possibly with intelligence and attitude measurements of the parents.

In general, the present findings are in accord with those of H E and M C Jones (14) and of Bridges (4). Most, if not all, of the crying responses of these infants could be described as occurring

with a failure (perhaps only momentary and partial) to make an adequate adjustment to the situation as it was perceived by the child. The total response varied from a massive reaction elicited by sudden physiological disturbance to active, directed attempts to regulate the environment. This latter behavior, of course, was in the form of an adjustment, as it was effective in bringing about relief through external agencies. If one can conclude that the original condition of unpleasant emotions is a marked interference with the normal functioning of the organism, its first expression may be that of undifferentiated distress, while somewhat later fear and rage evolve, depending for their differentiation—at least so far as the onlooker is concerned—on a submissive attitude of withdrawal or on an active combative attempt to remove the annoying stimulus. Whether there is a clear distinction between these in the infant's consciousness must remain a matter of conjecture, but it is probable that any such distinctions would be vague and rudimentary, since even in adults the two emotions often overlap, or give way to each other in rapid succession.

Little attempt has been made to determine what emotions accompanied the crying, as the reactions seemed, especially in the early months, largely undifferentiated. Crying when brought into a strange room, or when handled by strangers, may reasonably be classified as a fear reaction. It occurs sooner or later in all of the babies except the few who see many people, and who have been taken about frequently from early infancy. It does not occur until the child is old enough to discriminate the unusual elements in the situation (14) and is most reasonably attributed to the fact that the habitual responses to familiar situations are inhibited and no adequate adjustment to the strange situation is ready, the result is a blocking of positive responses and behavior marked by shrinking and withdrawing. Of the other causes of crying, continued handling seems sometimes to elicit the emotion of fear, sometimes rage, but often what appears to be simply distress. Rage frequently seems to be characteristic of "spoiled" crying, crying when laid down, temper at interferences with existing conditions, and (in the case of the older children) resistance to confinement of movements in the specific test situations. No stimulus which elicits an emotion can be relied upon to produce invariably the same emotional response unless it be the undifferentiated crying of the very young infant.

Since a child's emotions are due to specific causes which are effect-

ive at his level of development, a knowledge of what circumstances cause negative emotional reactions in children at different ages can be used to advantage, both by parents and by those who are conducting experiments with children. If one knows what things are likely to be disturbing at any given age, he can make an intelligent effort to avoid them. An outstanding illustration in the first year is that of fear of the strange situation The babies who were most disturbed by the experiments were those who were never taken anywhere except for their monthly visits to the Institute, and who saw few people outside of the immediate family. Such children will be afraid of the doctor who may be called in for illness, or of friends and relatives who call If, on the other hand, they are somewhat accustomed to strange persons and places during the period when these discriminations are developing, such experiences will be less radically unusual, and, accordingly, less likely to cause strong fear reactions. The experimenter, for his part, must learn a very cautious approach to babies who are past six months old, he must select, at least for the early part of the period, experimental situations in which he himself plays a very minor rôle In a similar way, one could indicate how crying for other causes may be decreased by a specified control of the conditions

Summary

In an experimental period in which infants were handled and observed for approximately an hour, the average amount of crying amounted to 15% of the total examination time There was a tendency for crying to become of shorter duration after the first month, reaching its lowest point at four months, then increasing again somewhat during the rest of the year.

When the different causes of crying were considered, it was found that some were outgrown and others acquired as the children grew older. In the earlier months crying resulted mostly from internal, organic causes—bodily pain and distress; later the external environment became an increasingly potent factor Such factors as fatigue at the end of the test, and colic pain, became relatively less important than fear of the strange situation and dislike of unusual handling In other words, the apparent periodicity in the amount of crying was shown to be due to the fact that the children tended to cry for different causes at different ages

Correlations between the percentages of crying at different age

levels show some consistency in an infant's emotionality (if we assume that crying is a criterion), especially during the second half year. Whether this is due to innate tendencies or to early environmental influences, the data do not show clearly. The fact that there is some consistency in the stimuli which are effective in any given child may be an indication of specific conditioning, though it does not preclude the possibility of innate individual differences in the readiness with which affective conditioning occurs

No relationship was found between the amount of crying and mental scores, socio-economic status, birth weight, birth order, or sex

One cannot determine the nature of the emotions felt by the child, but, in terms of overt behavior, his affective responses toward annoying stimuli gradually become diversified into patterns which are similar to those of adult emotions

The relation of crying to specific causes has a practical bearing in regard to child training, and to obtaining optimum experimental conditions in the study of children

References

1 Blanchard, P A study of subject matter and motivation of children's dreams *J Abn & Soc Psychol*, 1926, **21**, 24-37

2 Blanton, M G The behavior of the human infant during the first thirty days of life *Psychol Rev.*, 1917, **24**, 456-483

3. Blatz, W E, & Bott, E A Studies in mental hygiene of children—a description of method *J Genet Psychol*, 1927, **34**, 552-582

4 Bridges, K M B A genetic theory of the emotions *J Genet Psychol*, 1930, **37**, 514-526

5 Buhler, C Pubertatsverlauf bei Knaben und Madchen *Zsch f Sex-wiss*, 1927, **14**, 6-10

6 ———— The first year of life New York: Day, 1930 Pp 281

7 Busemann, A. Die Erregungsphasen der Jugend *Zsch f. Kinderforsch*, 1927, **33**, 115-137

8 Eng, H The emotional life of the child compared with that of the adult London Oxford Univ Press, 1925 Pp 243

9 Hall, G S A study of fears *Amer J Psychol*, 1896, **8**, 147-249

10 ————. Adolescence Vol 1 New York Appleton, 1904 Pp 784.

11 Heilman, J. D A revision of the Chapman-Sims socio-economic scale *J. Educ Res*, 1928, **18**, 117-126

12 Hetzer, H Systematische Dauerbeobachtungen am Jugendlichen uber den Verlauf der negativen Phase *Zsch f pad Psychol*, 1927, **28**, 80-104

13 Jones, H E. The retention of conditioned emotional reactions in infancy *J. Genet Psychol*, 1930, **37**, 485-497

13a ———— The conditioning of overt emotional responses *J Educ Psychol.*, 1931, **22**, 127-130

14 JONES, H E., & JONES, M C A study of fear *Childhood Educ*, 1928, **5**, 136-143.

15 ———— Genetic studies of emotions *Psychol Bull*, 1930, **27**, 40-64.

16 JONES, M. C A study of the emotions of preschool children. *School & Soc.*, 1925, **21**, 755-758

17 KEENS, H., & BLATZ, W. E A study of situations arousing emotional behavior in nursery-school children *28th Yrbk Nat Soc Stud Educ*, 1929, 615

18 LEHMAN, H C., & WITTY, P A Periodicity and growth *J Appl Psychol*, 1927, **11**, 106-116

19 LEVY, D M, & TULCHIN, S H The resistance of infants and children during mental tests *J Exper. Psychol.*, 1923, **6**, 304-322

20 LIPPMAN, H S Certain behavior responses in early infancy *J. Genet Psychol*, 1927, **34**, 424-440.

21 SHERMAN, M The differentiation of emotional responses in infants. I Judgments of emotional responses from motion picture views and from actual observation II. The ability of observers to judge the emotional characteristics of the crying of infants, and of the voice of an adult *J Comp. Psychol.*, 1927, **7**, 265-284, 335-351

22. STUTSMAN, R Mental measurement of preschool children Yonkers, N Y World Book Co, 1931. Pp x+368.

23 WASHBURN, R W A study of the smiling and laughing of infants in the first year of life *Genet Psychol. Monog*, 1929, **6**, 397-537

24. WATSON, J B. Psychology from the standpoint of a behaviorist Philadelphia Lippincott, 1919 Pp. 429

25. WECHSLER, D, & JONES, H. E A study of emotional specificity *Amer. J Psychol*, 1928, **40**, 600-612

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UNE ÉTUDE DES PLEURS DES JEUNES ENFANTS PENDANT LES TESTS MENTAUX ET PHYSIQUES

(Résumé)

Dans une période expérimentale où l'on s'est servi de 61 jeunes enfants et les a observés pendant environ une heure par mois, ils one pleuré en moyenne pendant 15 pour cent de la durée totale de l'expérience Les pleurs ont tendu à devenir d'une plus petite durée apres le premier mois, la durée étant la plus petite à quatre mois, et devenant un peu plus grande pendant le reste de l'année

On a trouvé que quelques causes de pleurs ont disparu et d'autres ont été acquises comme les enfants sont devenus plus âgés Dans les premiers mois les pleurs ont été causés le plus souvent par des causes intérieures organiques—la douleur et la souffrance du corps, plus tard, le milieu extérieur est devenu de plus en plus important, ce qui est montré par de telles causes que la peur d'une situation étrange, et l'aversion pour un

maniement non usuel. La périodicité évidente du montant des pleurs s'est montrée due au fait que les enfants ont tendu à pleurer pour différentes causes à différents âges.

Les corrélations entre le pourcentage des pleurs à différents niveaux d'âge montrent quelque constance dans l'émotionalité d'un enfant, surtout pendant le deuxième demi-an.

On n'a trouvé aucune relation entre le montant des pleurs et les résultats des tests mentaux, l'état socio-économique, le poids de naissance, l'ordre de naissance, ou le sexe.

Les réponses affectives de l'enfant aux stimuli ennuyeux se sont diversifiées peu à peu en formes semblables à celles des émotions des adultes.

La relation entre les pleurs et les causes spécifiques a une application pratique à l'entraînement des enfants, et à l'approche expérimentale dans l'étude des enfants.

BAYLEY

EINE UNTERSUCHUNG DES SCHREIENS VON SÄUGLINGEN IM VERLAUF GEISTIGER UND PHYSIOLOGISCHER UNTERSUCHUNGEN

(Referat)

Im Verlauf einer Untersuchungsperiode während der 61 Säuglinge jeden Monat ungefähr eine Stunde lang behandelt und beobachtet wurden, nahm das Schreien im Durchschnitt 15% der Prüfungszeit in Anspruch. Das Schreien erwies eine Tendenz zur Verkürzung nach dem ersten Monat, erreichte mit vier Monaten sein Minimum und nahm dann während den übrigen Monaten des Jahres wieder etwas zu.

Es zeigte sich, dass einige Ursachen des Schreiens entwachsen und andere erworben wurden, als die Säuglinge älter wurden. In den früheren Lebensmonaten wurde *das Schreien meistens durch innere, organische Ursachen* bedingt,—namentlich durch körperlichen Schmerz und körperliches Unbehagen. Später nahm die Wirksamkeit der äusseren Umgebung zu, was erwiesen wurde in solchen Ursachen wie z. B. Furcht vor der unbekannten Situation und Abneigung gegen ungewöhnliche Behandlung. Die scheinbare Periodizität des Schreiens erwies sich als durch die Tatsache begründet, dass die Kinder in verschiedenen Altern durch verschiedene Gründe zum Schreien bewegt wurden.

Korrelationen zwischen den Prozenten des Schreiens in verschiedenen Altern erwiesen eine gewisse Beharrlichkeit des Gefühlstypus eines Kindes, besonders während des zweiten Halbjahres.

Es zeigte sich kein Verhältnis zwischen dem Betrag an Schreien und den an Geistesprüfungen erhaltenen Zahlen, dem sozial-ekonomischen Stand, dem Geburtsgewicht, Geburtsrang, und Geschlecht.

Die Gefühlsreaktionen des Kindes störenden Reizen gegenüber differenzierten sich allmählich in Gestalten (patterns) die denen der Gefühlszustände Erwachsener gleichen.

Der Zusammenhang des Schreienes mit bestimmten Ursachen ist von praktischer Bedeutung für die Kindererziehung und für den experimentellen Angriff (approach) in der Kinderforschung (child study).

BAYLEY

THE BEHAVIOR OF WHITE RATS IN A ROTATED TUNNEL MAZE*

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The experiments reported below are intended to contribute to the study of the receptor processes used by the white rat in its maze performances, as disclosed in its behavior upon rotation of the maze. The fact is well known that rats and certain other animals will be confused when a maze which they have previously learned to traverse without error or hesitation is rotated 90 or more degrees from the position of learning. The causes of the phenomenon, however, have remained somewhat obscure, and there has been some tendency to suppose in the rat some magnetic or other special sense of absolute direction.

The view adhered to in the present experiments is opposed to such a conception. The rat is herein assumed not to possess any special sense of absolute direction, nor any receptor processes other than those it is known to have, nor to use those it possesses in other than the usual ways. The maze responses of rats, or of other animals having developed receptor processes, may be considered a form of homing, but not in any sense that would require specialized receptors. The maze responses of an animal are conditioned not only to the intra-maze situation of the animal, but also to the extra-maze situation, if the extra-maze situation can affect the animal's receptors in any manner, however slight. Further, the maze responses of an animal should be considered as beginning, not when the animal is inserted in the maze, but when, and as, it is taken from the home cage.

This view of the maze performances of the white rat is based partly on the experiments here reported and partly on experiments of prior investigators. In particular, mention is to be made of the general investigation of Carr (2) of the dependence of the maze behavior of rats upon the extra-maze situation, or, as Carr phrased

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it, "the wider sensory environment in which it is developed" This work was too extensive to be reviewed in detail here, but it included experiments in moving and rotating the living cages of blind and normal rats which had been trained to a particular maze, the maze remaining unaltered during changes in the position of the living cage. The maze performances of 70% of the normal animals were disturbed, the disturbance appearing in 41% of their trials, when the position in the room of the living cage from which they were taken was changed, 15 minutes or 24 hours before they were tested The greatest disturbance was after the 15-minute exposure Forty per cent of the blind animals were disturbed, disturbance appearing in 50% of their trials, but only after the 24-hour exposure

The living cage was also rotated while remaining in the same position in the room, and the animals tested 15 minutes and 24 hours later in an uncovered maze None of the normal animals were disturbed after 15 minutes' exposure in the rotated position, but after 24 hours all were disturbed, errors appearing in 40% of their trials. Of the blind animals all were disturbed after the 15-minute exposure, errors appearing in 57% of their trials After 24 hours 90% were disturbed, errors appearing in 62% of their trials.

The significance of these experiments seems apparent They are evidence of an effect upon the performances of an animal in the maze of the stimulation it has received from the home cage prior to running, an effect presumably reiterated and reinforced by the repeated trials necessary to train the animal to automatic maze performance.

Another experiment to be mentioned in this connection is the brief one of Leuba and Fain (14) The apparatus, unfortunately, is not fully described Apparently, an alley maze, Hampton Court pattern, was used, floor and alley walls being of wood, the top covered with wire mesh The living cage, also of wood and so constructed that the animals could see nothing of the outside room but the ceiling, was attached to the entrance of the maze The maze could be rotated separately, or maze and cage could be rotated as a unit In the latter case the rats were admitted to the maze for training and test trials by raising a sliding door separating the cage from the maze When the cage was detached, the rats were brought from cage to entrance of maze by hand or in a wire basket

When the maze, living cage attached, was rotated 90, 180, and 270 degrees, no change was observed in the behavior of the four

white rats used When, however, the cage was disconnected and the maze alone rotated 180 degrees, "the rats behaved as if in a new maze"

The importance of this experiment to the literature and knowledge of the rotation problem is surely considerable. The experiment could well be repeated with other types of maze and living cage and with a larger number of animals, but as it stands it does much to support the view that the maze response begins in the home cage.

If space permitted, other experiments might be cited in support of the view outlined in the foregoing paragraphs. In fact, the main body of the experimental evidence up to the present time would seem to support strongly the declaration originally made by Carr that though the maze performance of the rat is largely a tactual-kinaesthetic response to the maze itself, it, nevertheless, depends in some degree on a wider sensory situation from which it is never under most conditions wholly free In other words, the maze response is a locality response which begins in the home cage and is ordinarily affected by extra-maze as well as intra-maze influences The phenomenon of disturbance upon rotation arises from this fact and will always do so unless a maze and procedure are provided which will at least exclude the influence of the extra-maze situation upon the animal in the maze.

It was in the attempt to develop such a maze and procedure that the present experiments with the tunnel maze were undertaken[1]

Apparatus

There would seem reason to believe that the extra-maze situation may affect all of the rat's receptors At any rate, it seems certain that more than the visual receptors are involved, and probable that more than the olfactory receptors are involved. The rat in its native habit is, of course, a wall-following and semi-underground animal, and its locality-responses might thus well be mainly tactual-kinaesthetic Even so, however, it could have use for distance receptors, and the history of its maze performances suggests that it does on occasion use both eyes and nose in the maze performance, and there is further the possibility, as yet largely untested, that the ear is a receptor perhaps as important to the locality-responses of the animal as either the eye or the nose

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[1]Indebtedness to Professor W S Hunter for advice is gratefully acknowledged

It was hoped by use of the tunnel maze to reduce to some degree the influence of the extra-maze environment on all of the rat's receptor systems, and, particularly, to lessen the vulnerability of the visual and tactile and, to some extent, the auditory and olfactory receptors as avenues of disturbance. It was called a tunnel maze from the fact that the rat ran in a tunnel, the sides of which were of wood (five-ply birch veneer, three-eighths of an inch thick), and the floor and ceiling of ground glass one-eighth of an inch thick. Electric lights were located at intervals beneath the floor, illuminating the tunnel uniformly and in a manner such that the movements of the rat could be observed from above with the minimum chance that the animal would receive visual stimulation from outside the maze. The apparatus was used in a dark room.

Figure 1 shows the pattern of the maze, a triple-T, together with a cross-section of the tunnel and light chamber. Inside dimensions were: *A* to *H*, 25 inches; *F* to *G*, 50 inches, *C* to *B* and *D* to *E*, 46 inches. The inside width of the tunnel (*T*) and of the light chamber (*LC*) was four inches. The inside height of the tunnel was 3½ inches, of the light chamber, 12 inches. The upper surface of the floor of the tunnel was 7½ inches above the top of the 10-watt Mazda lights, one of which was located at the middle of each segment of the maze, six lights in all. *P* and *P* represent the position of the living cages of the rats in certain parts of the experiment in which the rats were subject to rotations while living on the maze.

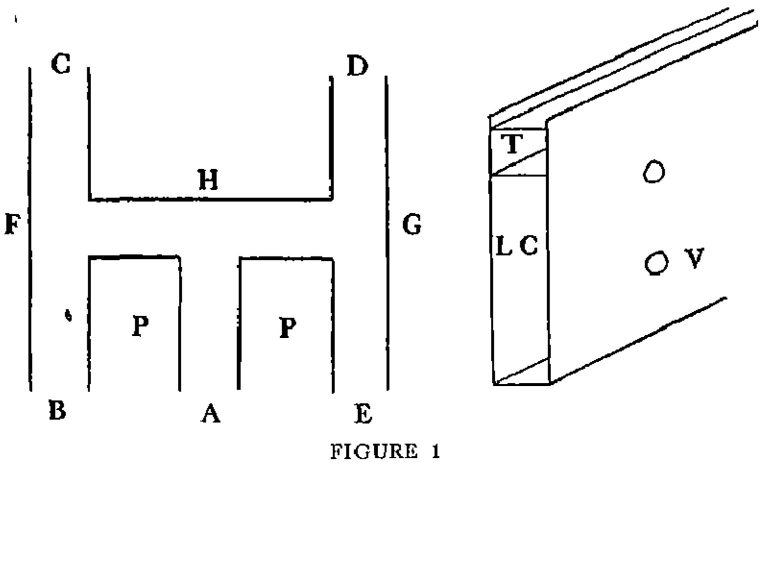

FIGURE 1

V represents ventilating holes, 1½ inches in diameter, located at each light to prevent heating These openings were on both sides of the apparatus, but only those on one side can be shown in the figures The upper edge of the upper opening in each case was 2 inches below the lower surface of the floor of the tunnel The sides of the tunnel and the sides and bottom of the light chamber were painted with three coats of flat white.

The rat entered the tunnel from a removable release box fitting into the tunnel at *A* and was received into a removable end-box fitting into the tunnel at whichever of the four exits, *B, C, D, E,* the rat was trained to use Exits not in use were closed with metal slides

As shown in Figure 2, the whole apparatus was mounted on a swivel, permitting rotation to any position of the compass, presumably without change of the stimuli which the rat received from the tunnel The swivel consisted of a Ford front wheel (Model T) and bearings, mounted horizontally as shown in the figure, and carrying a square framework of steel on which the structure of the maze rested

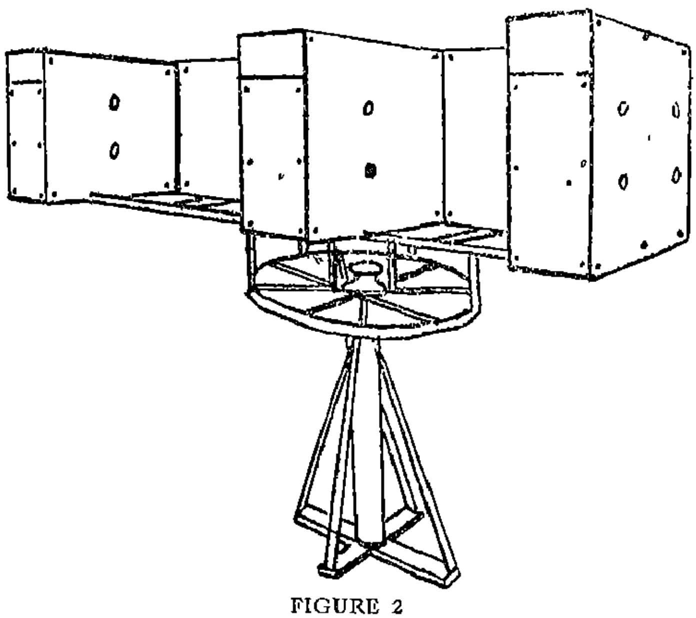

FIGURE 2

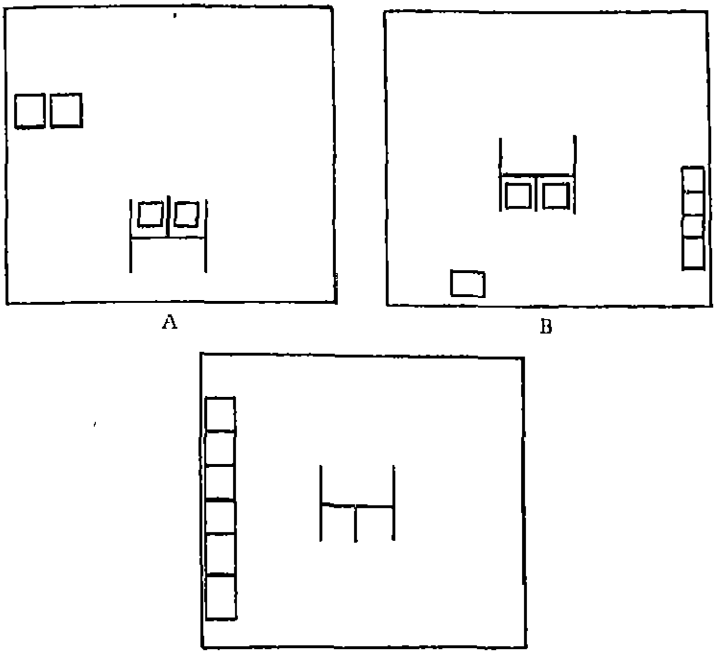

FIGURE 3

Positions of Living Cages Relative to the Maze (A) in Experiment I, (B) in Experiment II, and (C) in Experiment III

The maximum increase in temperature of the floor of the tunnel after two hours of illumination was 4 degrees Centigrade Experimental sessions varied in length from half an hour to two hours, but no effect of the slightly increased temperature was observable in last trials, which did not vary in time or errors from preceding trials unless rotation or other disturbance was introduced.

Figure 3 shows the relative positions of living cages and maze in the room for the three experiments here described The cages stood on small stands 25 inches above the floor in the same room with the maze, their distance from the entrance to the maze varying between 4 and 8 feet During Experiments I and II two cages were located on the maze itself in the positions P and P indicated in Figure 1.

The animals were carried from living cage to maze in the release box mentioned above. It was of heavy sheet tin, oblong, and provided with a hinged lid in the top by means of which the animal was placed inside A door in the forward end, opened by turning a small lever on the outside, admitted the animal to the maze. The box was 17 inches long by 3¾ wide by 3⅜ high. It slipped inside the maze alley at *A* (Figure 1) to a depth of 3½ inches.

The end-box receiving the animal at the conclusion of its run was made of wire meshing The entrance was provided with a slide door and with a square projection also made of meshing which fitted inside the maze tunnel. The entrance to the receiving box was thus a continuation of the tunnel. The outside of the box, except the top, was covered with several thicknesses of paper. The inside dimensions were, length 15 inches, width 10 inches, height 8 inches.

Procedure

Twenty-one white rats were used in Experiment I, 32 in Experiment II, and 25 in Experiment III. The animals for Experiments I and II were Wistar stock, males and females, ranging in age from 50 to 120 days at the beginnings of the experiments. The animals for Experiment III were from a strain used by the Biology Department of Brown University and were descended from rats originally procured from a local animal dealer. They were both males and females and varied in age from 50 to 150 days at the beginning of the experiment

Throughout the experiments the animals were run twice a day, morning and evening. The hour varied among the three experiments but was always so placed that there were approximately 12 hours between the two daily sessions

As a control of possible smell-tracking the animals were grouped, in each experiment, in cage groups of 4, 5, 6, or 7, each group being trained to use a different one of the four exits All exits were used equally throughout the experiments and no two groups used the same exit in immediate succession.

McCollum's diet, cooked and dried (9, p. 55), was fed during Experiment I. During Experiments II and III it was fed as a dry-meal mixture, with powdered skim-milk added, one part in eleven. This was done to save time in the care of the animals and because the quantity of food eaten from trial to trial was thus more easily

controlled The factor of food-odor is, of course, minimized by the use of McCollum's diet, whether it is cooked and dried or fed as a dry-meal mixture The quantity of food allowed each rat during training and test trials varied between 4½ and 7 grams daily, according to the performances of the animals If an animal was running satisfactorily it was permitted to eat for about 30 seconds after each trial, and again at the conclusion of the trials up to 5½ or 6½ grams. If, however, it showed persistent errors, it was allowed to eat only after each trial and was given extra trials. Two, or sometimes three, trials per animal were normally given in each session All animals received fresh lettuce and a small quantity of broken dog-biscuit daily The dog-biscuit is included in and not additional to the dry rations mentioned above

Care was taken not to frighten the animals They were handled quietly, quick movements being avoided, and were not given trials in the maze until they had been habituated to maze conditions, and to the release and end-boxes This was done by preliminary training in a small tunnel straightaway, provided with ground-glass ceiling and floor, under which electric lights were arranged in the same manner as on the maze The straightaway was 21 inches long and of the same interior height and width as the maze tunnel. The release and receiving boxes fitted into it in the same manner as with the maze

The duration of training was longer than is usually the case because of the importance of having automatic performances by the animals. It varied from group to group, the animals varying in the rate at which they reached automaticity and in the degree to which they maintained it. Approximately 15 days, 30 training sessions or 60 individual trials on the maze, might be named as the minimum duration of training, and 21 days as the maximum. No animals were tested with rotation until they had maintained automaticity for 8 to 10 trials

The rotation tests were given as the second or third trials in the experimental session. Two rotation tests in the same compass position or in different positions might be given in succession if disturbance did not appear on the first trial The main positions used were 90, 180, 270 degrees and 45, 135, 225 degrees, though more positions might be used in some cases

Errors were recorded by tracing on mimeographed outlines of the maze pattern the path taken by the animal. The tracings did not

follow exactly the actual movements of the rat as is done with the camera lucida, but were merely schematic indications of what it did on the maze, showing where the errors were made and their character. Errors of two types were counted: (*a*) cases in which the rat retraced on the true path, each additional maze segment being considered an additional error, and (*b*) excursions from the true path, each additional segment of the maze being an additional error. Movements toward the true path after such an excursion were not counted errors, but further movement away after a partial return was a further error.

Time records were taken with a stop-watch recording fifths of a second.

Results

The maze and procedure described here eliminated disturbance due to rotation with the 25 rats used in Experiment III, and significantly reduced it with the 53 animals used in Experiments I and II. No comment on the difference in behavior between the two stocks of animals can be made beyond the fact that the disturbed animals were descended from Wistar stock and the undisturbed were from the animal dealer stock. The only physical differences noted between the two strains were the slightly longer head, and the longer, smoother, and more compact fur of the Wistar stock, and, possibly, their greater vigor, though this is an impression. Both stocks were in complete health, alert, and very active throughout the experiments. Both showed characteristic disturbances in behavior, about equal in degree, when, in a preliminary experiment, an open elevated maze which they had learned was rotated 90 or more degrees from the position in the room in which they had learned it.

Carr has pointed out that with the open-top alley-type of maze, disturbance caused by rotation is occasional, occurring in a haphazard manner, many rotated trials being without error or lengthened performance time, and the number and character of errors varying from trial to trial. This is perhaps even more true with the tunnel maze, and there is the added difficulty that, with many animals which are disturbed, a lessened degree of disturbance is exhibited. In only 4 of the 78 animals tested in these experiments was consistent disturbance exhibited, disturbance measurable in errors or in materially increased performance time and manifested in more than 20% of the rotated trials. With many animals disturbance was

confined to a single error and lengthened performance time. Some disturbances may have been ascribed to rotation which were extraneous disturbances occurring during a rotated trial

Including, however, as due to rotation, disturbances which may have been extraneous, the rotated tunnel maze still produces irregularities in the animal's behavior less than Carr (2) had secured by rotating a glass-topped alley maze covered with a canvas tent, tent and maze rotating as a unit, and less than the writer had been able to secure in experiments carried out in 1928 with an enclosed elevated maze of the same pattern and practically the same pathway dimensions as the present tunnel maze

With the tent-covered maze, tent and maze rotating as a unit, Carr reported that 80% of a group of 10 normal rats were disturbed, errors appearing in 31% of the 48 rotated trials they received. The average error record per animal for the 48 rotated trials was 1 29

With the enclosed elevated maze, 40% of a group of 20 rats were disturbed, errors appearing in 19% of the 115 rotated trials they received The average error record per animal for the 115 trials was .32

With the tunnel maze in Number I of the present experiments, 28% of a group of 21 rats (Wistar stock) were disturbed, errors appearing in 9 7% of the 103 rotated trials which they received The average error record per animal was 33

With the tunnel maze in Number II of the present experiments, 34% of a group of 32 rats (Wistar stock) were disturbed, errors appearing in 8.6% of the 230 rotated trials they received. The average error record per animal was .14

With the tunnel maze in Number III of the present experiments, none of a group of 25 rats (animal dealer stock) was disturbed by rotation in any of the 104 rotated trials they received.

As a part of Experiments I and II, two cages of rats, 15 animals in Experiment I, 10 animals in Experiment II, were trained while living on the maze itself, the cages rotating with the maze, though not continuous with it as in the experiment of Leuba and Fain, but placed on both sides of the entrance (*P* and *P*, Figure 1), the level of the cage floors being 12 inches below the floor of the maze tunnel. The regular release box was used but was left in place at *A* (Figure 1), the rats being lifted up through an arc of approximately 16 inches from cage to lid of release box.

This procedure further reduced, but did not eliminate, the disturbance caused by rotation. The remaining irregularities were indeed so slight and occasional that at the end of Experiment I disturbance due to rotation was thought to have been eliminated. Repetition of the work, however, in Experiment II indicated that there was still a slight rotation irregularity. Of the 15 animals handled in this manner in Experiment I, 13% were disturbed, errors appearing in 2.3% of the 84 rotated trials they received. The average error record per animal for the 84 trials was .035. Of the 10 animals handled in this manner in Experiment II, 20% were disturbed in 4.0% of the 50 rotated trials they received. The average error record per animal for the 50 trials was .08.

The degree of irregularity in disturbed animals as shown by individual time and error scores (see Table 1 below) indicates not only fewer animals disturbed but disturbance noticeably less in degree when the cage is on the maze than when it is at the side of the room. In the majority of cases disturbance disappears. In one case, however (Rat No. 9), the animal exhibits disturbance when the cage is on the maze and not when it is at the side of the room. No explanation of this case can be offered beyond the suggestion that the irregularity exhibited when the living cage was on the maze may have been extraneous disturbance occurring in a rotated trial. It was confined to one trial.

The phenomenon of adaptation is believed not to affect the data in Table 1, although the same rats were, of course, rotated in the same maze to many of the same rotated positions when the living cage was on the maze and when it was at the side of the room. Carr has held that adaptation to one set of living-cage–maze relations does not give adaptation to another, and the experience of the present writer confirms this view. Further, Rats 1, 2, 5, and 6 of Table 1 received their first rotated trials living in a cage at the side of the room, whereas Rats 3, 4, 7, 8, 9, and 10 received their first rotated trials living in a cage on the maze.

The results secured with the tunnel maze may be made clearer by comparison with results obtained by the writer and another experimenter in 1928 in another rotation experiment. An elevated maze of the same pattern and substantially the same pathway dimensions as the tunnel maze was used. It also was a triple-T, and the part of the pathway corresponding to *AH* in Figure 1 was 24 inches long, as against 25 in the tunnel maze. *FG* was 50 inches,

TABLE 1

Rat No	Average time first three rotations	Errors first three rotations	Total rotations given	Average time	Total errors	Trials with error
			EXPERIMENT I			
			Cage at Side of Room			
1	11.6	4	5	12.4	7	2
2	8.9	3	6	5.5	3	1
3	12.4	5	3	12.4	5	1
4	33.4	6	5	21.1	6	1
5	41.8	8	6	29.4	8	3
6	18.0	5	6	9.8	5	2
			Cage on the Maze			
1	2.0	0	5	2.1	0	0
2	1.5	0	5	1.5	0	0
3	3.0	0	6	2.8	0	0
4	4.6	0	6	4.7	0	0
5	2.4	0	4	2.5	0	0
6	1.8	0	4	1.8	0	0
			EXPERIMENT II			
			Cage at Side of Room			
7	9.6	4	5	6.7	4	1
8	11.9	5	5	8.1	5	2
9	2.9	0	4	2.8	0	0
10	4.5	0	4	4.0	0	0
			Cage on the Maze			
7	4.3	1	5	3.4	1	1
8	2.2	0	5	2.1	0	0
9	9.0	3	5	6.5	3	1
10	2.1	0	5	2.1	0	0

CB and *DE*, 48 as against 46 inches in the tunnel maze. The maze pathway was 2 inches wide and was elevated 30 inches above a solid, linoleum-covered platform mounted on casters to facilitate rotation. As an unenclosed maze, it was rotated in the open room by revolving the platform

To make an enclosed maze, a large wall-board box with hinged ceiling was built around the maze on the platform in a manner such that maze and housing rotated as a unit The housing was practically light-tight, and the enclosed maze was used in a dark room with the only illumination in the interior of the housing and that reduced to the minimum requisite for observation of the animals

This was done through peep-holes cut in the end of the housing and covered with darkened glass. An enclosed release box similar in principle to the one employed in the present experiments was used to carry the animals from living cage to maze.

Table 2 is a tabular summary of the results obtained in rotation of the three kinds of maze There are also shown some of Carr's results in rotating the tent-covered alley maze. His data in many respects are not comparable to the present results, since he used a more complicated maze. They are comparable, however, in percentages of animals disturbed

The open elevated maze considerably exceeds the others in the degree of disturbance which rotation causes in the performances of the animals Although simpler than the alley maze of Carr, it shows a higher percentage of trials with error. Something of the sort might be expected, for of all the types of maze here compared the open elevated brings the animal into closest relations with the extra-maze environment, and hence most exposes it to changes in stimulation due to rotation Not only did the animals performing on this type of maze show the greatest disturbance, but they showed what it seems reasonable to regard as orientation on the basis of extra-maze landmarks. Like Carr's and Lashley's animals in similar situations, they were oriented to the locality in the room rather than the locality on the maze, where they had been fed before rotation

Though the open elevated maze exceeded the uncovered alley maze in disturbance of animals upon rotation, the enclosed elevated maze caused considerably less disturbance than the covered alley maze The percentage of animals disturbed in the enclosed elevated maze is 50% against 80% in the alley maze, and the percentage of trials with error 19 against 31. Part of the difference is no doubt due to the simpler pattern of the elevated maze, but part might reasonably be supposed to lie in the differing character of the two maze pathways and the differing character of the rat's performances on them Carr does not disclose the manner in which his maze was mounted—whether it rested directly on the floor or on casters. In either case, however, the pathway of the enclosed elevated maze might conceivably be better insulated against changes in stimulation in the pathway due to moving the maze over the floor than the alley maze, for the legs supporting the pathway of the enclosed elevated maze did not rest directly on the floor but on a particularly solid platform, and not directly on the platform, but on a large square of heavy linoleum covering it.

TABLE 2

Experiment	Essential conditions of experiment	Number of animals used	Total number of rotations	Percentage of trials with error	Average error	Percentages of animals disturbed
Carr, 1917	Alley maze, covered with canvas tent Maze and tent rotate as a unit Rats inserted by hand.	10	48	31 0	1 29	80
Newbury and Trueblood, 1928	Open elevated maze Rats carried in release box from cage to maze	15	75	90 6	12 30	100
Same, 1928	Enclosed elevated Rats carried in release box from cage to maze	20	115	19 0	32	40
The present experiments No I, 1929	Tunnel maze Rats carried in release box from cage to maze Cage at side of room Wistar rats used	21	103	9 7	33	28
The present experiments No II, 1930	Same as in No I Wistar rats used	32	230	8 6	14	34
The present experiments No III, 1930	Same as in I and II Animal dealer rats used	25	104	0 0	0 00	0
The present experiments No. I, 1929	Same as I and II except that living cage rests directly on maze	15	84	2 3	035	13
The present experiments No II, 1930	Same as above	10	50	4 0	08	20

Aside, however, from the physical characteristics of the pathway, *the behavior of a rat on an elevated maze is somewhat different from* its behavior in an alley maze On the elevated maze the animal apparently comes to depend less on its contact than on its distance receptors, even, it would seem, orienting partly by means of the latter [2] And, if the animal depends on its distance receptors more on the elevated maze than it does in the alley maze, and if it is the stimulation of the distance receptors, particularly the visual, which the enclosed elevated maze tends to keep most constant under rotated conditions, it should follow that the animal would be less disturbed when rotated on the enclosed elevated maze than when rotated in the covered alley maze

This view is to some extent supported by the differing degree and character of disturbance shown by animals on the open and enclosed elevated mazes Disturbance is not eliminated by enclosure of the elevated maze, but it is considerably reduced, and orientation seems practically eliminated. Of the animals performing on the open elevated maze 100% were disturbed in 90 6% of the rotated trials, against 50% disturbed in 19% of the rotated trials on the enclosed elevated maze. Further, the residual irregularity exhibited on the enclosed elevated maze was what might be described as diffuse or non-specific, compared with that on the open maze Disturbance might be exhibited only in lengthened performance time; or errors, if made, might occur almost anywhere on the pathway It seems reasonable to suppose that such phenomena are characteristic of behavior not much influenced by the visual receptor system At all events the receptor system the influence of which was most reduced by enclosure of the elevated maze was evidently the visual, since

[2]In this connection mention may be made of a striking experiment by Vincent (29, p 182). A group of normal white rats had been conditioned in an alley maze equipped with removable sides After they had reached automaticity, the sides were removed and the maze converted into a sideless elevated maze' "The rats had to relearn the maze almost as if it were a new problem The old habits did not meet the situation The animals went out upon the maze with flattened crawling bodies, they clung to the edges with their toes, they followed these edges with their vibrissae; they used apparently every tactual-cutaneous help possible While the fewer initial and total errors seem rather good evidence that something was carried over from one maze to the other, the fact that it took over eleven trials on an average for the relearning (as against sixteen for the original learning), as well as the evidence of the observed behavior, indicates that the habit had to be re-established *through new sensory aids*" (italics not in original)

the housing used did not completely insulate against sound or odor, and the maze pathway was the same with both open and enclosed mazes

Comparison of the results secured by using the enclosed elevated maze with those secured by use of the tunnel maze extends the same line of thought The tunnel maze, which still further reduces disturbance under rotated conditions, does so presumably by keeping constant not only the stimulation of the animal's visual receptors—which it does, doubtless, no more efficiently than the enclosed elevated maze—but also by keeping constant the tactual, and probably the auditory, stimulation which the animal receives from the passages of the maze. For, since the tunnel maze revolves uniformly on a single central pivot instead of making more or less variable contact, by means of casters, with a more or less variable floor surface, it would appear unlikely that the interior characteristics of the tunnel would be altered by rotation sufficiently to affect the rat's tactual or kinaesthetic receptors.

Such an interpretation is supported by the degree and character of the disturbance exhibited in the tunnel maze Irregularities have become still more vague Disturbance in many cases can only be inferred from hesitation on the part of the animal And not only is disturbance apt to be more vague when it appears, but it fails to appear in an increasing percentage of animals. This fact seems further to confirm the finding of Watson and Carr that the maze response of the rat is predominantly tactual-kinaesthetic· Animals which are not disturbed by rotation of the tunnel maze—and it appears that approximately 50% of those used in Experiments I and II, and all of those used in Experiment III, are not—may be animals which depend in their maze responses mainly on their contact receptors and their proprioceptors

The relation of the general facts of disturbance as here exhibited to the reported finding of Leuba and Fain, that disturbance ceases when the living cage is made continuous with the entrance of the maze, is not clear In the first place, the investigators have not described their equipment in a manner which will enable the reader to form a precise understanding of the real relations between the intra-maze and extra-maze environments of the animal Such description as is given, together with the diagram, suggests that the maze was of the open-top alley-type, but one knows nothing of the construction except that the maze was "of wood," and neither the

width of the alleys nor the height of the alley sides is disclosed, though the latter is a fact, probably, of considerable significance More is said of the living cage: "The walls of the living cage were of wood Wire mesh was stretched horizontally within the cage, about six inches below the top of the sides, so that the rats, when in the cage could see only a limited portion of the ceiling" (14, p. 242)

To attempt interpretation of this significant experiment in the absence of accurate information as to the nature of the relation between the intra-maze and extra-maze environments of the animal is a doubtful enterprise, but it may be undertaken. Apparently, an open-top alley maze was used, and as has already been pointed out, the behavior of the animals in an alley maze strongly suggests that in this type of maze they rely mainly on their tactual and kinaesthetic receptor systems for orientation Accordingly, it seems reasonable to suppose that cessation of disturbance when the living cage is connected with the maze is due chiefly to the fact that, as far as the receptor systems on which the animal mainly depends are concerned, connection of living cage and maze is simply the most effective method yet devised of eliminating the extra-maze environment as a determiner of the animal's behavior. When the living cage is continuous with the maze, and this type of maze is used, the rat may reasonably be described as preponderantly a kinaesthetic-tactile animal, responding in an environment in which the stimulation of the receptors, being preponderantly kinaesthetic-tactile, is not appreciably changed by rotation

When, however, the living cage is disconnected, even to the slight extent to which it was disconnected in Experiments I and II here reported, the behavior of the animal becomes in greater part determined by the stimulation of its distance receptors, and hence by the extra-maze environment Evidently, then, its responses, which are now determined by both the intra-maze and extra-maze environments, will be affected when the relations between the two sets of determiners of its behavior are disrupted by rotation.

Whether this interpretation is correct or not can be tested only by repetition of the Leuba-Fain experiment with a larger number of animals and with other types of maze, particularly the elevated maze.

Conclusion

In summary, it may be said that experimental studies of this problem up to the present time suggest the following general inferences with respect to the behavior of white rats on rotated mazes.

The behavior is a type of homing response which, however, is not determined by any special receptor that can be thought of as the agency of a sense of absolute direction Only the regular receptors are involved They are affected, and the consequent orientation of the animal is determined, by at least two, and in most cases three classes of stimulation (*a*) the stimulation from the home cage, (*b*) the stimulation from the intra-maze situation of the animal; and (*c*) the stimulation from the extra-maze situation.

During the period of training, if cage and maze remain in a fixed position of learning, the animal becomes conditioned to a certain fixed set of relations obtaining between these three classes of stimulation.

Rotation of the maze or the cage disrupts this fixed set of relations and hence disturbs the animal

The experimental elimination of disturbance caused by rotation is accomplished when the living cage is made continuous with the maze, and an enclosed or semi-enclosed maze used, through the facts (*a*) that extra-maze stimulation is thus practically excluded, and (*b*) that rotation, in this instance, does not alter the relation between intra-maze and home cage stimulation The same result is approached for some rats and reached for others by use of the tunnel maze technique It is reached for those animals, apparently, which depend most on their contact receptors and their proprioceptors

References

1 Bogardus, E S, & Henke, F G Experiments on tactual sensations in the white rat. *J Anim Behav*, 1911, **1**, 125-137.

2. Carr, H Maze studies with the white rat *J. Anim Behav*, 1917, **7**, 260-275, 277-294, 295-306

3. Carr, H, & Watson, J B Orientation in the white rat *J Comp Neur & Psychol.*, 1908, **18**, 27-44

4 Dashiell, J F Direction orientation in maze running by the white rat *Comp Psychol Monog.*, 1930, **7**, No 32 Pp 72

5 Donaldson, H H. The rat. (2nd rev ed) (*Mem Wistar Instit Anat & Biol*, No 6) Philadelphia Wistar Instit Anat & Biol, 1924

6 Gengerelli, J A. The effect of rotating the maze on the performance of the hooded rat *J Comp Psychol*, 1928, **8**, 377-384

7 ——— Preliminary experiments on the causal factors in animal learning *J Comp Psychol.*, 1928, **8**, 435-459, 1929, **9**, 245-274

8. Glaser, O C The formation of habits at high speed *J Comp Neur & Psychol*, 1910, **20**, 165-184

9 GREENMAN, M J., & DUHRING, F. L Breeding and care of the albino rat for research purposes. Philadelphia Wistar Instit Anat & Biol, 1923

10. HIGGINSON, G. D. Visual perception in the white rat. *J Exper. Psychol*, 1926, 9, 337-347

11 HUNTER, W S Some labyrinth habits of the domestic pigeon *J. Anim Behav*, 1911, 1, 278-304.

12. ——— The temporal maze and kinaesthetic sensory processes in the white rat *Psychobiol.*, 1920, 2, 1-17

13 LASHLEY, K. S Brain mechanisms and intelligence. Chicago Univ. Chicago Press, 1929 Pp 186.

14 LEUBA, J H, & FAIN, V Note on orientation in the white rat. *J Comp Psychol.*, 1929, 9, 239-244

15 LUBBOCK, SIR J. Ants, bees and wasps, a record of observations on the habits of the social *Hymenoptera* London, 1882 (Pp 250-273)

16 PATRICK, J R, & ANDERSON, A C The effect of incidental stimuli on maze learning with the white rat *J Comp Psychol*, 1930, 10, 295-307

17 PORTER, J. P Further study of the English sparrow and other birds *Amer. J. Psychol*, 1906, 17, 248-270

18 RICHARDSON, F A study of the sensory control in the rat *Psychol. Rev, Monog. Suppl*, 1910, 12 Pp 124

19 SACKETT, L. W The Canada porcupine a study of the learning process. *Behav Monog.*, 1913, 2, No. 7 Pp 83

20 SADOVINKOVA, M P A study of the behavior of birds in the maze *J Comp. Psychol.*, 1923, 3, 123-139

21 SMALL, W S An experimental study of the mental processes of the rat. *Amer J. Psychol*, 1899, 11, 133-165, 1900, 12, 206-239

22 ——— Notes on the psychic development of the young white rat *Amer. J. Psychol*, 1899, 11, 86-100

23 STONE, C P, & NYSWANDER, D B Reliability of rat learning scores from the multiple-T maze *J Genet. Psychol*, 1927, 34, 497-524

24 TOLMAN, E. C Purpose and cognition, the determiners of animal behavior. *Psychol. Rev.*, 1925, 32, 287-297

25 TRUEBLOOD, C. K A tunnel maze. *J. Genet. Psychol.*, 1929, 36, 581-583.

26 VALENTINE, W L Visual perception in the white rat. *J. Comp. Psychol*, 1928, 8, 369-375

27 VINCENT, S B The function of the vibrissae in the behavior of the white rat *Behav Monog.*, 1912, 1 Pp 81

28 ——— The mammalian eye *J. Anim. Behav*, 1912, 2, 249-255.

29 ———. The white rat and the maze problem *J Anim Behav*, 1915, 5, 1-24, 140-157, 175-184

30 WASHBURN, M. F The animal mind (3rd ed.) New York. Macmillan, 1926 Pp xiii+431

31 WATSON, J. B. Behavior: an introduction to comparative psychology New York. Holt, 1914 Pp. xii+439

32. ——— Kinaesthetic and organic sensations their rôle in the reactions of the white rat to the maze *Psychol Rev., Monog Suppl*, 1907, 8, No 33. Pp vi+100

33. ———. Behavior of noddy and sooty terns. *Carnegie Instit. Publ.*, 1909, **103**, 187-255.

34. YOAKUM, C. S. Some experiments on the behavior of squirrels. *J. Comp. Neur. & Psychol.*, 1909, **19**, 541-568.

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LE COMPORTEMENT DES RATS BLANCS DANS UN LABYRINTHE À TUNNEL MIS EN ROTATION

(Résumé)

On a entraîné 78 rats blancs de deux lignées différentes, 53 d'une lignée et 25 de l'autre, à traverser un labyrinthe à tunnel où ils n'ont pas été influences visuellement par ce qui se trouvait à l'extérieur du labyrinthe. A la fin de l'entraînement, on leur a fait subir des rotations du labyrinthe vers plusieurs directions de la boussole. Chez les 25 animaux d'une lignée le dérangement qui paraît ordinairement dans le comportement des animaux pendant la rotation d'un labyrinthe a eté eliminé. Chez les 53 animaux de l'autre lignée il a été très réduit, au point de vue du nombre des animaux derangés, et de l'étendue du dérangement montré chez les animaux individuels, mesuré par le nombre des épreuves où le derangement paraît.

De celles-ci et d'autres expériences résumées dans l'article, on tire la conclusion que les rendements du rat blanc dans le labyrinthe sont une forme du comportement dirigé vers la maison où les récepteurs de l'animal sont influencés, et sa orientation conséquente déterminée par deux au moins et dans la plupart des cas trois classes de stimulation, (1) la stimulation de la cage-maison; (2) la stimulation du labyrinthe, (3) la stimulation de ce qui se trouve à l'exterieur du labyrinthe. Pendant l'entraînement l'animal devient conditionné à un groupe fixe de relations trouvées entre ces trois classes de stimulation. La rotation du labyrinthe ou de la cage rompt ces relations et dérange l'animal. On élimine ce dérangement au moyen d'exclure l'influence de l'extérieur du labyrinthe sur les récepteurs de l'animal, et au moyen d'empêcher le changement des relations entre la stimulation du labyrinthe et celle de la cage-maison causé ordinairement par la rotation. On atteint un tel résultat chez plusieurs animaux, ou en joignant la cage à un labyrinthe semi-enfermé, ou en se servant de la technique du labyrinthe à tunnel décrit.

TRUEBLOOD

DIE TATIGKEIT WEISSER RATTEN IN EINEM ROTIERENDEN TUNNELLABYRINTH (ROTATED TUNNEL MAZE)

(Referat)

Es wurden 78 weisse Ratten aus zwei verschiedenen Gattungen—53 aus der einen und 25 aus der anderen Gattung—in der Durchkreuzung eines Tunnellabyrinthes dressiert, wobei verhindert wurde dass sie durch die ausserliche Umgebung des Labyrinthes visuell beeinflusst wurden Nach Vollendung der Dressierung wurden sie Rotationsbewegungen des Labyrinthes nach verschiedenen Kompassrichtungen unterworfen Bei den 25 Tieren der einen Gattung schied die Storung die sich gewohnlich nach Rotation eines Labyrinthes in der Tatigkeit zeight aus Bein den 53 Tieren der anderen Gattung wurde die Storung wesentlich vermindert, sowohl in Bezug auf die Zahl der gestorten Tiere wie auch in Bezug auf den Grad der an einzelnen Tieren erwiesenen Storung, an der Zahl der Versuche gemessen in denen sich Verwirrung gezeigt hatte.

Aus diesen und anderen in der Abhandlung besprochenen Versuchen wird gefolgert, dass die Labyrinthtatigkeiten der weissen Ratte eine Art heimsuchende Tatigkeit darstellen, wobei die Rezeptoren des Tieres beeinflusst und seine folgliche Orientierung bestimmt werden durch weingstens zwei und meistenfalls drei Reizarten: (1) den Reiz aus dem Heimkafig (home cage), (2) den Reiz aus dem Labyrinth, (3) den Reiz aus der Umgebung ausserhalb des Labyrinthes Wahrend der Dressierung wird das Tier durch eine bestimmte Gruppe von Verhaltnissen bedingt, die zwischen drei Reizgruppen bestehen Rotation des Labyrinthes oder des Kafigs unterbricht diese Zusammenhange und stort das Tier Eine solche Storung wird dadurch ausgeschlossen, dass man die Einwirkung der ausserlichen Umgebung des Labyrinthes auf die Rezeptoren des Tieres ausschaltet und die Abanderung der Verhaltnisse zwischen dem von dem Labyrinth und dem von dem Heimkafig ausgeubten Reiz, welche gewohnlich durch die Rotation verursacht wird, verhindert. Eine solche Ausschliessung wird bei vielen Tieren erzielt, entweder dadurch, dass man den Heimkafig ununterbrochen in ein halb eingehegtes (semi-enclosed) Labyrinth ubergehen lasst, oder durch das beschriebene Verfahren des Tunnellabyrinthes

TRUEBLOOD

AN INVESTIGATION OF COLOR VISION IN THE HOODED RAT*[1]

From the Psychological Laboratory of the University of Pittsburgh

NORMAN L. MUNN

INTRODUCTION

The only previous experiment on color vision in the rat is that of Watson and Watson (9) in which albino and hooded rats were shown to be color-blind While the animals could discriminate between monochromatic patches of red and green and yellow and blue light, control tests showed the red to have little or no stimulating value and yellow to have a much greater stimulating value, in terms of brightness alone, than the blue When the colors were approximated to each other in brightness the rats could no longer discriminate between them

The work of Yerkes (11), Waugh (10), and Hopkins (3) with mice have yielded somewhat similar results. Yerkes found that red possessed little stimulating value and that dancing mice could not discriminate between colors as such. He used colored papers and light filters as stimuli Waugh used similar methods to those of Yerkes and failed to find evidence of color vision in the common mouse Hopkins, using colored papers and spectral lights, found one mouse which seemed to give evidence of color vision. This mouse "distinguished between red and each of a great number of neutral intensities and showed certain other significant differences from the mice already described in mode of choice It was shown that his ability to discriminate between two neutral light fields of different intensities was not as fine as would be required to explain the results on the basis of brightness discrimination. . . The conclusion appears to be justified that this specimen could see the color red as a quality" (p 489) The mice trained to discriminate blue

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[1]I am indebted to Dr Davenport Hooker of the Department of Anatomy of the University of Pittsburgh for donating the rats and to Dr Robert T Hance of the Department of Zoology of the University of Pittsburgh for the room in which the experiment was conducted

could not discriminate it from Hering gray Number 13, while those trained to discriminate red could not discriminate it from Hering gray Number 49 Since Hopkins does not state in detail the controls used in his experiment with the one mouse that discriminated red, one cannot make a critical evaluation of this result

The above experimenters used a modification of the Yerkes-Watson discrimination apparatus. This apparatus has recently been subjected to criticism Fields (2), Lashley (5), and Munn (6) have found that visual discrimination problems which could not be mastered in the Yerkes-Watson apparatus have been readily mastered in other apparatuses It has been pointed out, in explanation of this result, that the Yerkes-Watson technique does not force the animal to react to the stimuli appearing at the ends of the alleys through which he goes in making his responses. Much of the activity manifested in the apparatus has no necessary connection with the problem to be mastered. The apparatus, furthermore, is so constructed that the animal, if he discriminates at all, must do so from a distance arbitrarily set by the experimenter Thus there is no recognition of the focalizing ability of the subject. Since the apparatus proved so inadequate for pattern discrimination, there is a chance that the results on color vision might be reversed if a more adequate apparatus were used. This is one of the considerations which led to the present experiment

The above experimenters attempted to set up color discrimination without first determining the brightness value *for the animal's eye* of the colors to be discriminated. They started the experiment with colors of different brightness and, after a discrimination had been obtained, either increased and decreased the brightness of the stimuli, or substituted various intensities of gray for the positive or negative stimulus In every case, except the one mentioned by Hopkins, this has led to a loss of discrimination There is a chance that the animal, when confronted by two colors of different brightness, may respond to brightness (which is known to be the easiest of all discriminations for an animal to make) and not to color as such, even though the color discrimination might be possible. If the animal were responding to brightness differences, it is not likely that he would be able to transfer immediately to color when the brightnesses were equated.

It seems to the writer that the only way in which one could obtain unequivocal results on color discrimination would be to first deter-

mine the brightness equivalents (for the animal's eye) of various colors, and then attempt to obtain a discrimination between two colors of the same brightness This was done in the present experiment

The writer planned to use monochromatic Wratten filters in order to approximate spectral colors It was thought advisable, however, to carry on a preliminary experiment with Hering papers If this experiment gave any evidence of color discrimination, a finer determination could then be made with the filters. As a matter of fact, however, the results of this preliminary experiment were so decisive as to make a continuation of the experiment seem unnecessary.

In the present experiment, then, the brightness values for the rat's eye of the Hering yellow, blue, green, and red papers is presented The brightness values are in terms of the Hering gray series of 50 steps The experiment also includes a determination of the ability of the hooded rat to discriminate between two colors of equal brightness (*to the animal*). These colors are Hering yellow and Hering green

Apparatus and Method

Apparatus. The apparatus has already been described in detail (6) It consists essentially of a discrimination chamber at the end of which are two doors containing the stimuli to be discriminated The door containing the negative stimulus is locked from behind while the other door is free to open upon being pushed by the animal's nose An electric grid extending across the apparatus in front of the doors enables the experimenter to shock the animal whenever he approaches or touches the incorrect door. Behind the doors is a food chamber where food is placed at a point equidistant from both stimuli. Each door contains a spring which causes it to close after the animal has passed into the food chamber This prevents retracing into the discrimination chamber after a response has been made. A 60-watt lamp placed 12 inches above the entrance door at a point equidistant from both stimuli was the source of illumination. The apparatus used in this experiment differed from the one described in my other experiment (6) in only one respect. A 2-inch partition similar to those used in the Yerkes-Watson apparatus was placed between the two doors. The response of the animals was sometimes so fast that it was almost impossible to give them a shock before they turned and entered the correct door after finding the incorrect one

locked The 2-inch partition was sufficient to slow up the animal's response and allow the experimenter to close the electric circuit while the rat was on the grid in front of the incorrect door.

Method. The method has also been described in detail (6). The animals were first allowed to run through the apparatus to the food box for several trials with both doors open. After the association between running through the apparatus and obtaining food had been set up, both doors were closed, but not locked. Neither of them contained stimuli to be discriminated. After the animal had learned to push the doors open with his nose in order to obtain food, the stimuli were inserted, the incorrect door was locked, and the experiment proper was begun The stimuli were, of course, changed from side to side of the apparatus in a chance order They could be slid out of a groove in the doors and exchanged

The stimuli were cut from fresh Hering papers. Each stimulus consisted of a square of Hering gray or colored paper, 10 centimeters on the side, pasted in the center of a piece of black cardboard which would just slide into the groove in the door The paper was carefully pasted so that no wrinkles appeared in the stimuli.

A response was always counted as incorrect if the animal touched the negative door A response was considered correct only when the animal approached and entered the door containing the positive stimulus without having made a positive response to the door containing the negative stimulus. Thus the texture of the paper comprising the stimulus could not aid the animal's discrimination. Other precautions against the use of extraneous stimuli were as follows: A screen hid the experimenter from the animal's view; there was no current in the grid until the animal had stepped on it and the experimenter had closed the switch; fresh stimuli were inserted from time to time to prevent a possible use of olfactory stimuli, both doors were unlocked at times to determine whether possible vibrations of the unlocked door, as the animal ran towards it, were aiding the discrimination; the stimuli were withdrawn and reinserted from time to time, whether the order of presentation called for a change or not, in order to determine the influence of the noise of making the change, the animal was always returned from the food box to the entrance of the discrimination chamber by the same route to prevent the possibility of a position habit based upon a difference in the routes after correct and incorrect responses, finally, the animals were not handled by the experimenter during the experiment, but were carried in a box from food chamber to entrance.

The initial discrimination was between a 100 cm ^{2} patch of colored paper and a patch of Hering gray paper Number 50 of the same size. After the discrimination had been mastered, the brightness of the gray was approximated, one step at a time, to the brightness of the color until the animal could no longer discriminate If the discrimination broke down on, say, Hering gray Number 15, it was considered that the brightness value (for the rat) of the color being discriminated was approximately equal to Hering gray Number 15 In this manner the brightness equivalents of the four Hering primary colors were determined In the final experiment two colors of approximately equal brightness (for the rat) were used as stimuli The method was the same throughout the entire experiment except that shock was not administered during the approximation series

The experiment was begun with four hooded rats obtained from the Department of Anatomy of the University of Pittsburgh. Two of these rats died before the experiment had been completed, hence complete data are available for only two rats The animals were fed a daily ration of sunflower seeds, bread and milk, Grape Nuts, and lettuce leaves Bread and milk and sunflower seeds were used as reward during the experiment From 20-50 daily trials were given each rat These were given during the noon hour in a darkened room The rats were brought from a well-lighted room at the beginning of each day's trials

TABLE 1

DISCRIMINATION BETWEEN HERING GRAY NO 50 AND HERING YELLOW

Yellow positive

	Percentage correct in 20 trials		
Trials	Rat 1	Rat 2	Rat 3
20	20	20	35
40	25	40	40
60	65	60	30
80	30	55	55
100	60	50	50
120	50	70	65
140	65	60	80
160	75	50	75
180	70	50	75
200	80	60	100
220	90	75	100
240	90	95	100
260	100	100	100

TABLE 2

APPROXIMATION OF THE GRAY TO THE BRIGHTNESS OF THE YELLOW

	Rat No 2			Rat No 3	
No of the Hering gray	No of trials	Percentage correct	No of the Hering gray	No. of trials	Percentage correct
50–15	360	96	50–15	360	98
14	20	85	14	20	80
13	10	100	13	10	80
11	10	100	12	10	80
12	10	100	11	10	100
10	10	90	10	10	100
9	10	100	9	10	90
8	10	90	8	10	100
7	20	75	7	20	70
6	10	70	6	10	70
8	10	80	8	10	80
9	10	100	9	10	90
8	10	100	8	10	80
7	10	60	7	10	50
8	10	80	8	10	50
7	20	65	8	10	50

RESULTS

Yellow-Gray Discrimination. It will be seen from Table 1 that from 180 to 240 trials were necessary to set up a discrimination between black (No. 50) and yellow. The animals were trained to react positively to the yellow stimulus. Table 2 presents the results obtained when the brightness of the gray stimulus was gradually increased Hering gray Number 49 was substituted for Number 50. As this did not affect the accuracy of response, Number 48 was then substituted This procedure was continued with every step in the Hering-gray series until the rats could no longer discriminate. After the response broke down, I went back toward the darker grays several steps and again determined the threshold.

From the table it will be seen that the brightness value of the yellow stimulus was approximately equal to Hering gray Number 7. Neither of the animals could discriminate yellow from Hering gray Number 7, whereas they could maintain a high accuracy of discrimination with Number 8. The record for rat Number 3 shows that he did not regain the discrimination of Number 8 after his final breakdown on Number 7. This is because he developed a left position habit during the preceding trials and I did not take the trouble to retrain him.

TABLE 3

BLUE-GRAY DISCRIMINATION

Approximation of gray to the brightness of the Hering blue

Rat No 2			Rat No 3		
No of the Hering gray	No of trials	Percentage correct	No of the Hering gray	No. of trials	Percentage correct
50–32	200	93	50–32	190	96
31	10	90	31	10	100
30	10	90	30	10	90
29	10	50	29	10	60
31	10	100	31	10	80
30	10	80	30	10	80
29	10	70	29	10	70
28	10	70	28	10	80
27	10	50	27	10	70
26	20	65	26	20	55

Blue-Gray Discrimination. It was not necessary to retrain the rats for this experiment When Hering blue and Hering gray Number 50 were presented the subjects discriminated the blue without further training. The approximation of the gray to the brightness of the blue was carried out as before. Table 3 presents the data for this experiment It will be seen that the discrimination was maintained from gray Number 50 to Number 31. At Number 30 the rats began to show unusual hesitation and at Number 29 they could no longer discriminate Further trials demonstrated that the threshold was at approximately 30 This was true for both of the subjects

TABLE 4

GREEN-GRAY DISCRIMINATION

Approximation of gray to the brightness of the Hering green

Rat No. 2			Rat No 3		
No of the Hering gray	No of trials	Percentage correct	No of the Hering gray	No of trials	Percentage correct
50–11	430	100	50–11	430	95
10	10	90	10	10	80
9	10	60	9	10	70
11	10	90	8	10	80
10	10	90	10	10	90
9	10	80	9	10	80
8	10	80	8	20	70
7	20	45	7	20	55
8	10	80	8	10	80

The brightness value of blue for the eye of the rat seems, then, to be at about Hering gray Number 29

Green-Gray Discrimination The rats needed no further training to discriminate between Hering green and Hering gray Number 50 Their responses were perfect for the initial 10 trials and they maintained a high degree of accuracy from Number 50 to Number 11, as Table 4 shows At Number 10 they began to show hesitation, Numbers 9 and 8 could be discriminated with an accuracy of 80%, and Number 7 could not be discriminated with better than chance accuracy. Hence the brightness value of green was shown to be approximately equal to Hering gray Number 7

Red-Gray Discrimination. Table 5 shows that the rats could not discriminate between red and Hering gray Number 50 Rather than train them in order to see whether the discrimination could be mastered, I thought it better to start with a light gray (using this, instead of the color, as positive stimulus) and decrease the brightness of the gray I started rat Number 2 with Hering gray Number 10. He discriminated this gray from the red without training, apparently still retaining the brightness discrimination from the other experiments.

TABLE 5
RED-GRAY DISCRIMINATION
Approximation of gray to the brightness of the Hering red

No of the Hering gray	Rat No 2 No of trials	Percentage correct	No of the Hering gray	Rat No 3 No of trials	Percentage correct
50	50	44	50	50	50
10–35	260	98	20–35	160	98
36	10	100	36	10	100
37	10	100	37	10	100
38	10	90	38	10	80
39	10	60	39	10	80
40	10	70	40	20	85
39	10	90	41	20	50
40	20	85	40	10	60
41	20	75	41	10	70
40	10	90	40	10	90
41	10	60	41	10	50
40	10	90	40	10	100
41	10	60	41	10	40
37	10	90			
38	10	90			
39	10	80			
40	10	100			
41	10	40			

Rat Number 3 was started with Hering gray Number 20, to which he responded without training. Both rats gave good evidence of their ability to discriminate between Hering gray Number 40 and the red, but no evidence of ability to discriminate when Hering gray Number 41 was the positive stimulus.

This experiment seems to indicate that Hering red and Hering gray Number 41 were of approximately equal brightness for the rats used. I expected to find the animals breaking down at a lower brightness than this. Hopkins (3), with his mice, found an inability to discriminate between red and Hering gray Number 49, but he does not say whether all of the steps below that gray were used. Washburn and Abbott (8), using rabbits as subjects, found red to be equal in brightness to Hering gray Number 46, although only three grays were used. Kittredge (4) found that calves could discriminate between Hering gray Number 5 and red, but not between gray Number 15 and red. Only two grays were used, however. Other workers in the field have demonstrated that red has low stimulating value. [See Stagner (7) for a review of this literature.]

The only comparable data concerning the other colors are those of DeVoss and Ganson (1) on cats, wherein they found that blue has low stimulating value, and those of Hopkins (3) in which blue seemed to be equivalent to Hering Number 13. Neither of these experiments involved a careful determination by using the whole series of grays.

Discrimination of Two Colors of Equal Brightness. I hardly expected to find two of the Hering colors so close in brightness value as green and yellow were found to be. (If these colors had not been of the same brightness to the rat I should have found it necessary to use filters and a moving light to regulate the brightness value of the colors. I should then have determined the brightness value of the colored filters by training the rats to discriminate them from a neutral filter. Two colored filters could thus be equated in brightness for the rat's eye.)

Since both the yellow and green stimuli were approximately equal in brightness to Hering gray Number 7 for the eye of the rat, I decided to determine whether the animals could discriminate between them.

One rat was required to respond positively to the green, the other rat to the yellow. The training method was the same as in the previous experiments. Eight hundred and fifty trials were given, but at

TABLE 6

GREEN-YELLOW DISCRIMINATION

Brightness of green approximately equal for the rat's eye to Hering gray No. 7. Brightness of yellow approximately equal to Hering gray No 7.

Trials	Percentage correct in 50 trials Rat No 2	Rat No 3
50	52	44
100	64	46
150	64	42
200	58	40
250	48	48
300	48	44
350	68	42
400	50	48
450	56	44
500	56	50
550	60	60
600	52	50
650	62	52
700	48	44
750	50	46
800	50	52
850	50	50

Rat No. 2 was trained positively to the yellow, Rat No 3 to the green In the final trials the former had a position habit to the left, the latter to the right.

no time did the rats indicate any ability to discriminate. It will be seen from Table 6 that the highest percentage of correct responses in any 50 trials was 68. This was apparently a purely chance response, since it could not be maintained. The animals went from one position habit to another; at other times they showed great hesitation in front of the two doors before attempting to open them, but it is extremely doubtful whether they could ever have mastered the response. By the 850th trial the results were no better than at the start At this point the experiment was discontinued

The rats were well motivated throughout and there seemed to be no extraneous factor which might interfere with their ability to discriminate, hence one was forced to the conclusion that they could not discriminate between Hering green and Hering yellow

CONCLUSIONS

The results of this investigation indicate that the Hering primary colors have the following brightness values, in terms of the Hering

gray series, for the eye of the hooded rat. yellow, 7; green, 7; blue, 29, and red, 41

The animals used in this experiment were unable to discriminate between Hering yellow and Hering green, which, to their eyes, possessed the same brightness value.

One is forced to the conclusion, therefore, that the subjects of this experiment were color-blind This conclusion is in general conformity with the work of other experimenters who have used rats, mice, and other infra-primate mammals as subjects (7).

References

1 DeVoss, J C, & Ganson, R Color blindness of cats *J Anim Behav*, 1915, 5, 115-139

2 Fields, P E Form discrimination in the white rat *J Comp Psychol*, 1928, 8, 143-158

3 Hopkins, A. E. Vision and retinal structure in mice *Proc Nat Acad Sci.*, 1927, 13, 488-493

4 Kittredge, E. Some experiments on the brightness value of red for the light-adapted eye of the calf *J Comp. Psychol*, 1923, 3, 141-145

5 Lashley, K. S. The mechanism of vision I A method for rapid analysis of pattern-vision in the rat *J Genet Psychol*, 1929, 37, 453-460.

6 Munn, N L An apparatus for testing visual discrimination in animals. *J Genet Psychol*, 1931, 39, 342-358

7 Stagner, R Visually determined reaction in vertebrates (A general review of the literature) *Psychol Bull*, 1931, 28, 99-129.

8 Washburn, M. F., & Abbott, E Experiments on the brightness value of red for the light adapted eye of the rabbit *J Anim Behav.*, 1912, 2, 145-180

9 Watson, J. B, & Watson, M I A study of the responses of rodents to monochromatic light *J Anim Behav*, 1913, 3, 1-14

10. Waugh, K T The role of vision in the mental life of the mouse *J. Comp. Neur. & Psychol*, 1910, 20, 549-591.

11 Yerkes, R M The dancing mouse. New York Macmillan, 1907 Pp. xxi+290

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UNE ÉTUDE DE LA VISION DES COULEURS DANS LE RAT ENCAPUCHONNÉ

(Résumé)

Cette étude comprend, (1) une détermination de la valeur de clarté des couleurs Hering rouge, jaune, vert, et bleu pour l'oeil du rat encapuchonné, et (2) un essai de faire une discrimination entre différentes couleurs de la même valeur de clarte *pour le rat* Les déterminations de clarté ont été faites en termes de la série de gris Hering de cinquante degrés. L'appareil s'est composé d'une chambre à discrimination où l'animal s'est trouve en face de deux portes Une porte, contenant un stimulus coloré, a conduit tout de suite à la nourriture L'autre porte, contenant un stimulus gris, a été fermée et l'animal a reçu un choc électrique quand il l'a touchée Après que l'on evait obtenu une discrimination entre gris Hering No. 50 et un stimulus coloré, on a approché peu à peu la clarté du gris à la clarté de la couleur jusqu'à ce que l'animal n'a plus pu discriminer entre les deux Les déterminations de cette sorte ont montré que les valeurs de clarté des couleurs primaires Hering pour l'oeil du rat ont été à peu près les suivantes, jaune, 7, vert, 7, bleu, 29, et rouge, 41 Les animaux n'ont pu en 850 épreuves montrer la capacité de discriminer entre le jaune et le vert, couleurs de la *même* valeur de clarté Il faut donc tirer la conclusion que *le rat encapuchonné est daltonien Ces resultats corroborent en général* les résultats des autres étudiants de la vision des couleurs chez les mammifères infra-primates

MUNN

EINE UNTERSUCHUNG DES FARBENSEHVERMÖGENS DER BEHAUBTEN RATTE

(Referat)

Die vorleigende Untersuchung besteht aus (1) einer Bestimmung der Helligkeitsweite von Hering Rot, Gelb, Grun und Blau fur das auge der behaubten Ratte, und (2) einem Versuch eine Fahigkeit zur Unterscheidung verschiedener Farben des gleichen Helligkeitswertes bei der Ratte einzufuhren Die Unterscheidungen der Helligkeitswerte wurden an der Heringschen Serie von Grau in 50 Stufen unternommen Der Apparat bestand aus einem Unterscheidungs-Raum, in dem das Tier zwei Turen gegenuber gestellt wurde Die eine Ture, die einen Farbenstimulus enthielt, fuhrte direkt zu Futter. Die andere Ture, die einen grauen Stimulus enthielt, war verschlossen und wenn das Tier sie beruhrte, erhielt es einen Schock Nachdem ein Unterschied zwischen Hering Grau No 50 und einem Farbenstimulus *erhalten worden war, wurde der Helligkeitswert des Grau* allmahlich dem Helligkeitswert der Farbe angeglichen bis das Tier nicht langer zwischen den beiden unterscheiden konnte Derartige Bestimmungen zeigten, dass die Helligkeitswerte der primaren Hering Farben fur das Auge der behaubten Ratte ungefahr die folgenden Zahlen ergaben Gelb 7, Grün 7, Blau 29 und Rot 41 In 850 Versuchen waren die Tiere nicht imstande, zwischen Gelb und Grun, Farben des gleichen Helligkeitswertes, zu unterscheiden Man ist daher zu dem Schlusse gezwungen, dass die behaubte Ratte farbenblind ist. Diese Resultate stimmen in Allgemeinen mit dem Resultat anderer Forscher uber das Farbenschvermogen infraprimater Saugetiere überein.

MUNN

VISUAL PATTERN DISCRIMINATION IN THE DOG*[1]

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HARRY W KARN AND NORMAN L. MUNN

INTRODUCTION

Johnson (2) and Williams (8) failed to obtain evidence of pattern vision in the dog They used a modification of the Yerkes-Watson apparatus. This apparatus has been subjected to recent criticism by Fields (1), Lashley (3), and Munn (5) These investigators found that, while rats could not be trained to discriminate visual patterns in the Yerkes-Watson type of apparatus, they readily mastered such discriminations in other types of apparatus It occurred to the writers, therefore, that the negative results obtained with dogs might be due to the inadequacy of the Yerkes-Watson technique rather than to defective vision in the dog

The apparatus chosen for this investigation was similar to one devised by Munn (5) for use with rats This apparatus was chosen in preference to that of Lashley, which yields similar results with rats, because it was considered to be better adapted to the dog

The object of the present experiment, then, was to determine the ability of the dog to discriminate visual patterns under conditions similar to those used with rats Besides the work of Johnson (2) and Williams (8), only three other investigations of pattern discrimination in the dog have been reported. Lubbock (8), Orbeli (6), and Shenger-Krestovnikova (6) report positive results, but, owing to inadequate controls, their work is not satisfactory. Williams (8) and Stagner (7) have reviewed the entire literature on pattern discrimination in animals

APPARATUS

The apparatus used in this experiment is similar except for size to that used by Munn (5) in his work on pattern discrimination

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in rats. It was constructed of "mesonite" (except for the doors) nailed to a wooden frame The entire structure had a height of 46 inches. This prevented the animals from jumping over the sides. The apparatus was painted black. The ground plan and further dimensions are presented in Figure 1.

The animal enters the apparatus through entrance door (*a*) and finds himself in discrimination chamber (*b*), where he is confronted by two stimuli placed on doors (*d*) and (*d'*), respectively. If door (*d*) contains the positive stimulus and the animal responds correctly he passes over grid (*c*) without shock, through door (*d*), and on to (*e*), where he finds food If he responds to the negative stimulus he gets a shock while on the grid and, on finding the door locked, is forced to respond to the other door containing the correct stimulus before he can gain an exit from the discrimination chamber and obtain food. It is to be noted that the animal is not shocked until he signifies an incorrect response by touching the door containing the negative stimulus The stimuli on doors (*d*) and (*d'*) are illuminated by means of a light located directly over entrance door (*a*).

The doors for the presentation of the stimuli were made of three-ply panel board, and were hinged to a common middle piece. Small metal channels were tacked to the inner surface of each door These channels held the stimulus cards in place and allowed their easy removal whenever necessary. A flat spring was fastened on the back of the middle partition and so arranged as to lie flatly upon the outer surfaces of both doors After the animal had passed through one of

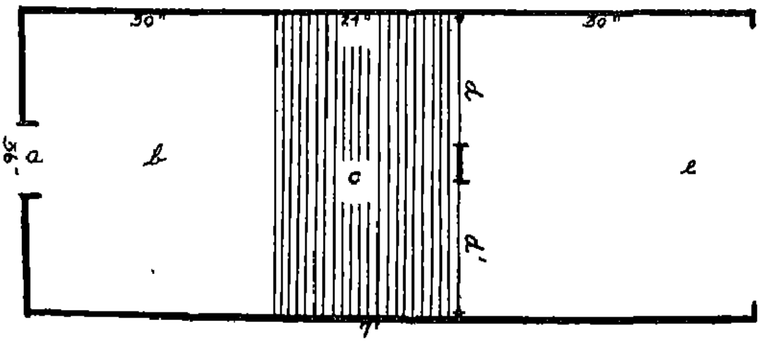

FIGURE 1
GROUND PLAN OF APPARATUS

the doors from the discrimination chamber the spring automatically caused the door to shut. A small slide-bolt was used for locking the door containing the negative stimulus.

Illumination was provided solely by the use of one 60-watt lamp. This light was placed on the inner surface of the front panel of the discrimination chamber equidistant from each side The light was located 38" from the ground and at such an angle as to allow its rays to fall directly upon the stimuli

The electric shock was obtained from the regular 110-volt circuit and passed through a 1750-ohm, 5-ampere rheostat It was necessary to regulate the shock for each animal, inasmuch as individual differences in behavior were manifested toward the strength of the shock The experimenter controlled the shocking device by means of a single-throw switch located at the front of the apparatus above the entrance door Close to this switch was an opening through which the experimenter could observe the animal's behavior at all times without being observed by the animal.

The stimuli were carefully cut from heavy cardboard and mounted in the center of the respective doors For nature, size, and variety of stimuli see separate descriptions under the various experiments

General Method

The apparatus was set in a different room from that in which the animals were kept The room containing the apparatus was practically dark except for the light coming from the single lamp in the discrimination chamber When the animals were first obtained they were led to the apparatus and allowed to wander through it This was continued for about a week. After the first week, one of the doors was locked and the other left unlocked. The animals soon learned that in order to get out of the apparatus they would have to push the door open Throughout this procedure the cards containing the stimuli were at no time presented to the dogs. After this preliminary work the first set of stimuli were inserted At about 8·30 o'clock each morning the first dog was released He immediately went into the adjoining room containing the apparatus and began pawing on the entrance door He was usually given from 20-30 trials and then led to his cage where he was given additional food. The procedure was then repeated for the second dog.

Every aspect of the experiment was rigidly controlled at all times

The stimuli were always presented in a chance order so as to prevent the animals from learning the order of presentation. The food was located at a point equidistant from both doors, thus preventing olfactory cues. The experimenter was shielded from the dog's view while it was in the apparatus. After the animal had learned a task he was given extra trials with both doors unlocked so as to make certain that he was not receiving cues from the vibrations of the unlocked door In changing the cards on the doors it was necessary for the experimenter to make some little noise with the locking devise. This noise was made, even though the cards were not changed, in order to prevent possible cues from this source The experimenter thus returned to the rear of the apparatus after every response Shock was administered to the animal only after he touched the door containing the negative stimulus. With such a procedure the animal could not possibly use the shock as a cue to a correct response

The *subjects were two male mongrels, Jerry and Judge, of unknown* lineage and age Both were healthy and well motivated. Judge worked fast in contrast to Jerry, who was slow and "cautious" at all times Jerry made a better subject than Judge The animals were fed on a mixed diet of meat, vegetables, and dog biscuits

Results

Experiment 1 Black-White Discrimination In this experiment the problem consisted of a discrimination between black and white stimuli. The positive stimulus was a piece of white cardboard the exact size of the door, held in place with thumb tacks, while the negative stimulus was a piece of black cardboard of identical size

Table 1 shows that both animals mastered the problem in 60 trials

TABLE 1
BLACK-WHITE DISCRIMINATION
Positive stimulus—white cardboard
Negative stimulus—black cardboard

Trials	Percentage correct in 20 trials Jerry	Judge
20	50	60
40	65	60
60	100	90
80	100	100

TABLE 2

DISCRIMINATION OF HORIZONTALLY AND VERTICALLY STRIPED PATTERNS

Positive stimulus—vertical stripes.
Negative stimulus—horizontal stripes

Trials	Percentage correct in 20 trials Jerry	Judge
20	50	30
40	35	35
60	50	55
80	40	70
100	60	70
120	70	70
140	75	70
160	80	75
180	95	90
200	90	95

This experiment involved a rather simple task, and was used primarily as a means of getting the animals thoroughly adapted to the experimental situation.

Experiment 2 Discrimination of Horizontally and Vertically Striped Patterns. After the animals had mastered the black-white discrimination they were given a task involving a discrimination between horizontally and vertically striped patterns The positive stimulus was the pattern with vertical stripes The stripes, which appeared on a white ground 9¾" square, consisted of parallel strips of black paper ¾" wide and 9¾" long alternating with open spaces of the same area The patterns were held in the centers of the doors by means of the small metal channels previously described. The stimulus cards were never changed from one door to the other When it was necessary to alter the stimuli from left to right and vice versa, the cards were simply removed, rotated though an angle of 90 degrees, and reinserted.

As in the previous experiment, the results were positive. Table 2 shows that both dogs mastered the problem in 180 trials with a final accuracy of over 90%

Experiment 3 Discrimination of Equilateral Triangles The positive stimulus in this experiment was an equilateral triangle, with sides of 9", presented on its base The negative stimulus was an identical triangle presented on its apex The triangles were cut out of white cardboard and pasted onto a black background The controls were likewise cut out of cardboard, and each combination was

of equal area and brightness. Figure 2 shows the stimuli and controls used in this experiment The controls were used in order to determine if the animals were responding to a triangular form as a totality or some particular aspect of the form such as base, apex, side, etc. As with the previous experiment the cards were never

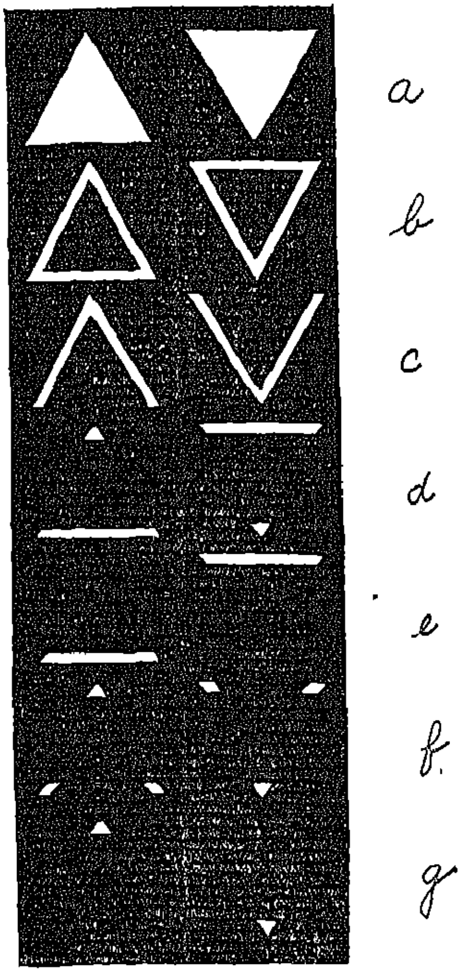

FIGURE 2
STIMULI USED IN EXPERIMENT 3

TABLE 3

DISCRIMINATION OF EQUILATERAL TRIANGLES—SIDES 9 INCHES

Positive stimulus—triangle on its base Negative stimulus—triangle on its apex Equal area and brightness

Trials	Percentage correct in 50 trials Jerry	Remarks
50	46	
100	58	
150	54	
200	62	
250	52	
300	50	
350	54	
400	68	
450	58	
500	52	
550	60	
600	68	
650	76	Shock discontinued
700	82	
750	84	
800	84	
850	90	

TABLE 4

CONTROLS FOR JERRY

Trials	Control (see Figure 2) combination	Percentage correct	Remarks
860	*b*	60	Position habit
870	*a*	60	Position habit
880	*a*	70	Position habit
890	*a*	90	
900	*a*	90	
910	*b*	90	
920	*b*	80	
930	*a*	90	
940	*c*	90	
950	*c*	80	
960	*a*	80	
970	*d*	90	
980	*d*	100	
990	*a*	90	
1000	*e*	90	
1010	*e*	90	
1020	*a*	90	
1030	*f*	90	
1040	*f*	80	
1050	*a*	90	
1060	*g*	50	Greatly disturbed
1070	*g*	50	Greatly disturbed
1080	*a*	80	
1090	*g*	50	Greatly disturbed

changed from one door to the other When it was necessary to alter the stimuli, the cards were removed, rotated 180 degrees, and re-inserted.

The results of this experiment were positive for Jerry Table 3 shows that he mastered the problem in 700 trials with a final accuracy of 90%

After the 850th trial the control combinations were inserted The results are shown in Table 4

The above table shows that Jerry went into a position habit to the left upon insertion of the first control series (Combination *b*). He was given 40 trials to the right with the original forms before the controls were again inserted This time the animal discriminated with an accuracy of 90%. Control Combinations *c, d, e, f,* and *g* were inserted in the order stated, and with each of them the animal discriminated with an accuracy of 80% or over with the exception of *g*, when he broke down completely On this last combination he paced to and fro in the discrimination box and responded with an accuracy of only 50%, which was no doubt due to chance. Before

TABLE 5

DISCRIMINATION OF EQUILATERAL TRIANGLES—SIDES 9 INCHES

Positive stimulus—triangle on its base Negative stimulus—triangle on its apex. Equal area and brightness.

Trials	Percentage correct in 50 trials Judge	Remarks
50	58	
100	64	
150	60	
200	60	
250	60	
300	54	
350	72	
400	68	
450	78	
500	70	
550	70	
600	68	Shock discontinued
650	80	
700	80	
750	72	
800	78	
850	80	
900	84	
950	80	

TABLE 6
CONTROLS FOR JUDGE

Trials	Control (see Figure 2) combination	Percentage correct	Remarks
960	*b*	70	
970	*b*	80	
980	*a*	70	
990	*c*	70	
1000	*c*	80	
1010	*a*	90	
1020	*d*	80	
1030	*d*	80	
1040	*a*	80	
1050	*e*	70	
1060	*e*	80	
1070	*a*	90	
1080	*f*	90	
1090	*f*	70	
1100	*a*	80	
1110	*g*	40	Greatly disturbed
1120	*g*	50	Greatly disturbed
1130	*a*	70	
1140	*g*	50	Greatly disturbed

each control series the animal was given ten trials with the original stimuli, and, except for the time when he went into the position habit, he maintained an accuracy of over 90% Shock was never administered during the control series.

The results for Judge were positive to the extent indicated in Table 5

As can be seen from the preceding table, the responses were quite variable. At times the animal would make discriminations with an accuracy of 90% in 20 trials, and then fall to 70% and sometimes less on the next 20 trials. The experimenter observed throughout the course of this experiment that this animal often failed to look at the stimuli which confronted him When he did raise his head and look at the stimulus cards the responses, especially towards the end of the experiment, were usually correct The shock failed to induce the animal to respond to the stimulus The behavior just described may account for the unusual variability of the responses

After the 950th trial the control combinations were presented Table 6 shows the results

The above table shows that the responses during the controls were of the same variable nature as those of the training period proper

TABLE 7

DISCRIMINATION OF EQUILATERAL TRIANGLES OF DECREASING SIZES

Positive stimulus—triangle on its base. Negative stimulus—triangle on its apex Each combination of equal area and brightness.

Trials	Size of triangles	Percentage correct in 10 trials Jerry	Remarks
1100	9 inches	90	
1110	8 inches	90	
1120	7 inches	80	
1130	6 inches	90	
1140	5 inches	90	
1150	4 inches	90	
1160	3 inches	90	
1170	2 inches	50	Disturbed
1180	3 inches	90	
1190	2 inches	40	Disturbed

It does seem significant, however, that the animal broke down completely on Combination *q*.

Experiment 4 Discrimination of Equilateral Triangles of Decreasing Size This experiment was supplementary to Experiment 3 It involved an attempt to determine the size threshold for the triangles The positive stimulus was an equilateral triangle, with base down, and the negative stimulus was an identical triangle with apex down After retraining the animal from the break-down on the final control combination of the last experiment, a combination of equilateral triangles with sides of 8″ was presented The triangles were then decreased in size, one inch at a time, until the dog could no longer discriminate between them. This experiment was carried out only with Jerry, since the previous results with Judge were of such an unsatisfactory character as to make further work with him inadvisable.

Table 7 shows that the dog maintained his ability to discriminate between equilateral triangles, one with base down and the other with apex down, until the sides were decreased to 2″.

SUMMARY OF RESULTS AND CONCLUSIONS

Discrimination between a black and a white stimulus was obtained in 60 trials with an accuracy of 100% The same animals discriminated between horizontally and vertically striped patterns, with stripes ¾″ wide and 9¾″ long, in 180 trials with a final accuracy of 90-95% One dog demonstrated unequivocal evidence of discrimina-

tion between equilateral triangles with 9″ sides when one triangle was presented with base down and the other with apex down. A gradual reduction of the size of the equilateral triangles showed that this dog could maintain the discrimination until the sides were 2″ The second dog demonstrated evidence of a similar discrimination between equilateral triangles of 9″ sides The results from the latter animal were of such a variable nature that no positive statements can be made concerning his performance

A series of control experiments in conjunction with the discrimination of the equilateral triangles of 9″ sides yielded results which showed that the animals could maintain a high degree of accuracy in discrimination so long as the base, or two corners of the base line, were present The subjects could not discriminate when these features were missing

While the above results force us to conclude that the dog possesses the capacity to discriminate visual patterns, they do not indicate whether the response is to the entire pattern, to form *per se*, or to particular features of the stimuli. Since the lower corners and the base of the triangle appeared to be equivalent to the whole triangle, it seems likely that the animal responds to shape (i e, a differential retinal distribution of light), rather than to triangularity or the total configuration

References

1 FIELDS, P E Form discrimination in the white rat. *J Comp Psychol*, 1928, 8, 143-158.

2 JOHNSON, H M Visual pattern discrimination in vertebrates A demonstration of the dog's deficiency in detail vision *J Anim. Behav*, 1916, 6, 205-221

3. LASHLEY, K. S The mechanism of vision I A method for rapid analysis of pattern vision in the rat *J Genet Psychol*, 1930, 37, 435-460

4 MUNN, N. L Concerning visual form discrimination in the white rat. *J Genet Psychol*, 1929, 36, 291-302

5 ——— An apparatus for testing visual discrimination in animals *J Genet Psychol.*, 1931, 39, 342-358

6 PAVLOV, I P Conditioned reflexes London Oxford Univ Press, 1927 Pp xv+430

7. STAGNER, R Visually determined reactions in vertebrates *Psychol Bull.*, 1931, 28, 99-129

8 WILLIAMS, J A Experiments with form perception and learning in dogs *Comp Psychol Monog*, 1926, 4 Pp 70.

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LA DISCRIMINATION VISUELLE DES FORMES CHEZ LE CHIEN

(Résumé)

Dans un appareil où l'on a placé les stimuli sur des portes que les animaux doivent ouvrir, deux chiens ont pu discriminer entre des stimuli noirs et blancs de même superficie, des formes rayées horizontales et verticales, et des triangles de la même superficie et de la même clarté lesquels diffèrent à l'égard de leurs sommets. Des expériences de contrôle où les contours des triangles, les trois coins des triangles, les lignes des bases, les deux côtés, et les bases et les sommets des triangles ont remplacé les premiers triangles n'ont pas influé sur la précision de la réponse Quand on a remplacé les triangles seulement par les sommets, les animaux n'ont plus pu discriminer. D'autres contrôles où les côtes des triangles ont éte réduits de neuf a trois pouces n'ont pas influé sur la precision de la réponse Quand les côtés n'ont été que de deux pouces la réponse a eté seulement celle sur laquelle on pourrait compter selon le hasard De nombreux contrôles ont prouvé clairement que les animaux ne discriminaient aucunes suggestions exterieures Quoique les résultats nous forcent à conclure que le chien possède la capacite de discriminer des formes visuelles, ils n'indiquent pas si la réponse est à la forme entiere, à la forme *per se*, ou à des traits spéciaux des stimuli Puisque les coins inférieurs et la base du triangle *ont paru equivalents à tout le triangle, il paraît que l'animal repond à la* forme (c'est-à-dire, une distribution différentielle de lumière sur la rétine) plutôt qu'à la forme triangulaire ou a la configuration totale des stimuli

KARN ET MUNN

DAS UNTERSCHEIDUNGSVERMÖGEN VISUELLER GESTALTEN BEI HUNDEN

(Referat)

In einem Apparat, in dem die Stimuli an Turen angebracht waren, die von den Tieren geoffnet werden sollten, waren zwei Hunde imstande, zwischen schwarzen und weissen Stimuli des gleichen Flacheninhaltes, zwischen horizontalen und vertical gestreiften Gestalten, und zwischen Dreiecken des gleichen Flacheninhaltes und Helligkeitsweites die in Bezug auf die Lage ihrer Apices verschieden waren, zu unterscheiden. Kontroll Experimente, in denen Umrisse der Dreiecke, die drei Ecken der Dreiecke, die Grundlinien, die beiden Seiten und die Basis und die Apices (Spitzen) der Dreiecke fur die ursprunglichen Dreiecke eingesetzt worden waren, hatten keinen Einfluss auf die Genauigkeit der Reaktion Wenn nur die Spitzen eingesetzt waren, konnten die Tiere nicht mehr unterscheiden. Weitere Kontroll Versuche, in denen die Seiten der Dreiecke von neun zu drei Inches reduciert waren, hatten keinen Einfluss auf die Genauigkeit der Reaktion Als die Seiten zwei Inches massen, war die Reaktion nicht besser als wenn sie zufallig gewesen ware Zahlreiche Versuche bewiesen mit absoluter Sicherheit, dass die Tiere keinerlei aussenstehende Zeichen unterschieden Obwohl die Resultate uns zwingen, den Schluss zu ziehen, dass der Hund Unterscheidungsvermogen fur visuelle Gestalten besitzt, beweisen sie nicht, ob die Reaktion sich auf die gesamte Gestalt bezieht, auf Form an sich, oder auf bestimmte Eigenschaften der Stimuli Da die unteren Ecken und die Basis des Dreieckes das ganzen Dreieck darzustellen schienen, ist es wahrscheinlich, dass das Tier vielmehr auf Form (d h, eine differenziert retinale Verteilung von Licht) reagiert als auf das Dreieckige oder die gesamte Gestaltung der Stimuli

KARN UND MUNN

A STUDY OF SOME FACTORS INFLUENCING FORM-BOARD ACCOMPLISHMENTS OF TWO- AND THREE-YEAR-OLD CHILDREN*[1]

From the Iowa Child Welfare Research Station, State University of Iowa

HAROLD MANVILLE SKEELS

This study aims to investigate experimentally and analytically certain factors related to form-board performance of a group of two- and three-year-old children The major factors included were (1) form discrimination, (2) variations in meaning by a study of accomplishments with two dimensional forms of common animate and inanimate objects as compared with geometrical forms, (3) some positional elements such as the effect of location and position of recesses and blocks, (4) number complexity, and (5) comprehension of relationship between blocks and recesses

With these objectives in mind five series of experiments were planned, including four series of form boards and one of silhouettes The first series of form boards included six boards of geometrical forms in increasing complexity. The second series included two boards with animate and inanimate object forms. The third series incorporated identification of all blocks and recesses used in the two previous series, identification being made either by the naming or the designation method. The fourth series used the Goddard-Seguin form board presented in two positions The fifth series included a group of 40 silhouettes, including the 18 forms (geometrical, animate, and inanimate objects) used in the form-board series and 22 additional ones These were presented in groups of four and were identified either by naming or designating

PRELIMINARY EXPERIMENT

The Goddard-Seguin (1) form board was given to 65 children between two and five years of age in the preliminary experiment In

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[1]This study was directed at the Iowa Child Welfare Research Station by Dr Beth L Wellman

presenting the board the position of the board on the table before the child was such that the diamond was in the lower left-hand corner. The blocks were placed to the right of the board in a single layer of random order. The experimenter sat opposite the child in a position which permitted observation of the child's activities and the recording of movements In all cases the child stood while performing the experiment. After preliminary remarks to obtain rapport the experimenter said, "You put the blocks in the holes where they belong just as quickly as you can." A second and a third trial was given with the following instructions, "Now you put the blocks in the holes where they belong again, just as quickly as you can." Inasmuch as this experiment aimed at an analysis of the difficulty of the various forms, it was thought best to avoid the set placement of the blocks used by previous experimenters and instead have a single layer of random order. Information recorded included the time for each trial, number and type of errors, order of placement and attempts at placement for each block, and any remarks of the child relative to the test. On the basis of this preliminary experiment the following tentative conclusions were made: (1) the high percentage of errors in the two- and three-year age levels would indicate that the task was too difficult and that random activity was an important factor in the performance; (2) the diamond and the lozenge were most frequently confused; (3) blocks and recesses similar in shape tended to be confused more often than those dissimilar; (4) position of recesses in relation to the source of block supply was a factor influencing frequency of errors An analysis of percentage of errors in vertical rows of recesses showed that the first row (that next to block supply) received 42% of the total errors made, the second row received 35%, and the third row (the one most distant from the block supply) only 23% of the errors [2]

Main Experiment

Five series of experiments constituted the battery of tests used in the main experiment These tests were devised on the basis of the results of the preliminary experiment. All of the boards were made of kiln-dried birch. Hard wood was used in order to give greater accuracy in dimensions and amount of play. The boards were constructed by laminating a ⅝-inch-thick surface to a ½-inch bottom

[2]A detailed analysis of these data are on file at the Iowa Child Welfare Research Station

board. Recess openings extend through the thickness of the surface board to the bottom board.

Geometrical block sizes were made identical with those of the same forms used in the Goddard-Seguin form board. These sizes were adopted in order that the results of the author's series might be compared with those of the Goddard-Seguin board. One element of change was made, namely, an increase in the amount of clearance between the blocks and the recess edges. In these boards 1/8-inch play rather than 3/32-inch play as in the Goddard-Seguin was used in both the geometrical and the object-form-board series. The blocks are all 7/8-inch thick, giving a projection of 1/4 inch above the surface of the board when placed in recesses.

Color was kept constant throughout, the boards being an antique

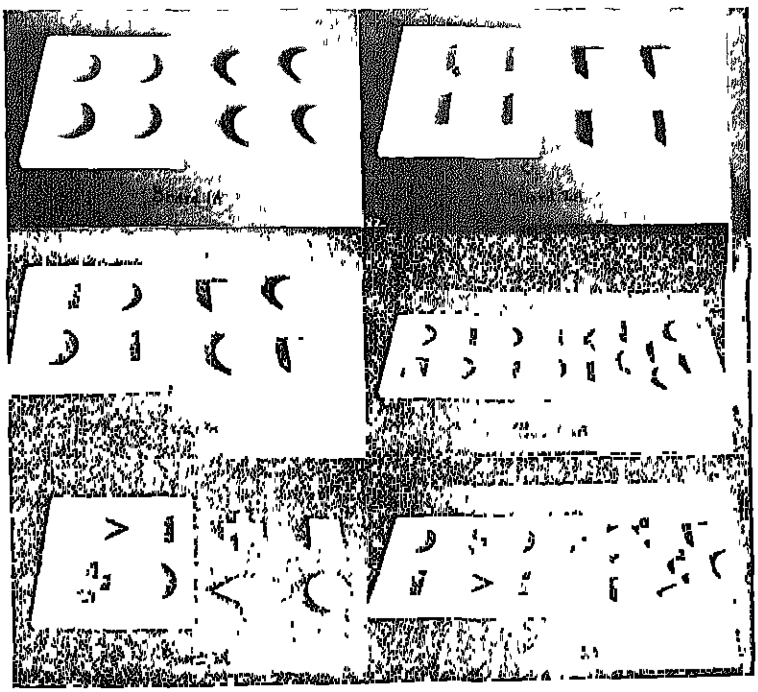

FIGURE 1
GEOMETRICAL FORM-BOARD SERIES

ivory matte surface and the blocks and recesses a brilliant scarlet. It was thought that contrast between the color of the surface of the boards and the form units might be a further aid in discrimination.

Forms used in the silhouette series are comparable in size to those used in the form-board series.

Certain divisions were set in the various series in order to avoid fatiguing the child. It took ten testing periods for each child to complete the battery of tests.

Usually the interval between the test periods was one day. In some instances, because of absences and sickness, this was exceeded by a few days.

Geometrical Form-Board Series

Based on previous studies and preliminary experimentation definite criteria were adopted for the selection of forms used in the geometrical form-board series. These criteria were: (1) usage of forms in previous studies, (2) low frequency of errors as shown in the preliminary experiment, (3) simplicity from the standpoint of motor coordination required for placement, (4) lack of geometrical resemblance between forms in a given board, and (5) constancy of configuration of a given form in all four positions of the board.

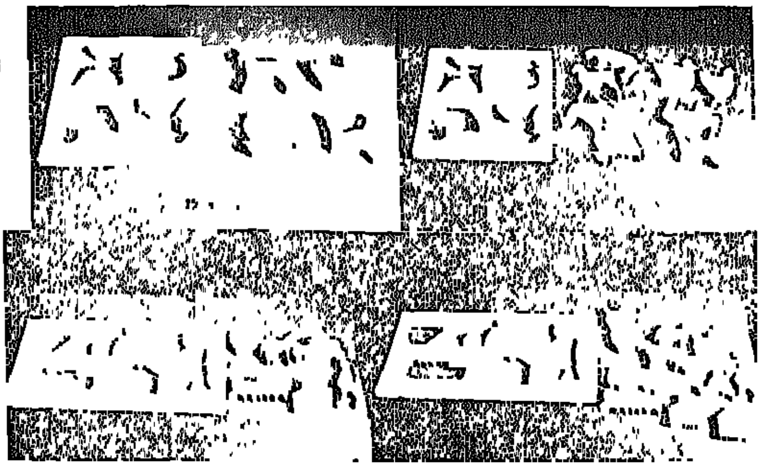

FIGURE 2
Object Form-Board Series

With this basis of selection, the circle was selected as the simplest form and has, therefore, been used as the only form in Board 1A. Similarly, the square form was used in Board 2A. Comparative errors made with the square and rectangle did not show outstanding differences; however, on a basis of constancy of configuration the square was selected. On the basis of the relative motor difficulty and the number of errors, the cross rather than the star was selected as the third form. Three forms of somewhat similar geometrical appearance were considered in the choice of the fourth form of the series, namely, the lozenge, the diamond, and the triangle. The diamond was eliminated as it was found to be the most difficult of the Goddard-Seguin board. On the basis of relative motor difficulty and because it was felt that it was well to have one form in which the configuration was not constant, the lozenge rather than the triangle was chosen.

Six boards of increasing difficulty constituted the geometrical form-board series. These included in order: (1) Board 1A, a board with four circular recesses; (2) Board 2A, a similar board with four square recesses; (3) Board 3A, containing two circle and two square recesses; (4) Board 4A, the same as 3A except that each element was doubled, making four circle and four square recesses; (5) Board 5A, containing four different form recesses, including the Maltese cross, lozenge, square, and circle; and (6) Board 6A, identical with 5A except that each form was doubled, making two Maltese-cross, two lozenge, two circle, and two square recesses.

Presentation. The form board was placed on the table adjacent to the edge of the table next to the standing child, with the blocks at the right of the board. Instructions were given to the child as follows: "You put the blocks in the holes." At the same time the examiner pointed first to the blocks and then to the recesses. No time limit was set for the performance of the task. The child continued until the test was completed or until he left the task, refusing to work longer.

Boards 1A and 2A were presented first, alternately; that is, to one child Board 1A was presented first with Board 2A following second, the next child received Board 2A first, followed by Board 1A. Boards 1A and 2A were followed by Board 3A. If one or more successes occurred with 3A, Board 4A followed. If all four trials on Board 3A were failures, Board 4A was omitted on the supposition that the same board containing more units would be fully as diffi-

cult or more so Board 5A followed Board 4A with the previously mentioned qualifications. This was followed by Board 6A unless four failures occurred

Board 1A. Board 1A was presented with four circle blocks to the right of the board The child was limited to two successes or a total of four trials If the first and second trials were both successes the child was given Board 2A next. If a failure and a success occurred a third trial was given. With success, the board was discontinued, with failure, a fourth trial was added.

Board 2A. Board 2A was presented with the four square blocks at the right of the board Two successes or a maximum of four trials was allowed.

Board 3A. The position of the board on the first trial was alternately with the squares in the upper left and the lower right corners and the upper right and lower left corners The two circle and two square blocks were placed at the right of the boards, similarly spaced as the recesses except that the circle block and square block next to the board were not placed adjacent to their recesses, but rather the square block was adjacent to the circle recess. For the second trial the board was turned through an arc of 90 degrees to the right.

Two successes or a maximum of four trials were allowed as in previous boards If third and fourth trials were given the board was again turned through an arc of 90 degrees to the right prior to each trial The position of the board was, therefore, the same in the third trial as in the first trial, and the same in the fourth trial as in the second trial

Board 4A Similarly, Board 4A was presented with four circle blocks and four square blocks at the right of the board in random order The position of the board was kept constant throughout the series as the purpose of this board was not to study position but rather the effect of the increase in numbers As in the previous tests, two successes or four trials were given If four failures occurred on Board 3A, Board 4A was not presented

Board 5A This board was presented with the four form blocks at the right of the board No block was placed adjacent to its correct recess, distances between blocks being approximately the same as the distances between recesses.

Four trials in four positions were given each child irrespective of failure or success. The position of the board for the first trial

was alternately with the circle in the upper left corner, next the upper right, then lower right, and lower left For example, one child would receive the board with the circle in the upper left corner for the first trial, the next child would have the board with the circle in the upper right corner, and so on For the second trial and each subsequent trial the board was turned through an arc of 90 degrees to the right

Board 6A Board 6A was presented with eight blocks at the right of the board, including two circle, two square, two Maltese cross, and two lozenge blocks in random order, with the exception that the two blocks adjacent to the board were not next to their correct recesses

The board was placed alternately with the circle recess in the upper left corner and in the lower right corner for the first trial For the second trial the board was turned through an arc of 180 degrees to the right The first and third trial would, therefore, have one position and the second and fourth trial the other Two successes or four trials were required

Object Form-Board Series

Two boards were used in the two-object form-board series (A and B) Board 7A with two each of two forms and Board 8A with six forms were used in both series. The same boards with additional blocks were used in the B series

All the forms used in these form boards were arbitrarily selected From an adult standpoint forms were selected which would be familiar to most two- and three-year-old children

In Board 7A, two dog and two duck forms were used For Board 8A, six forms were arbitrarily selected with the idea of including two inanimate stationary object forms, two inanimate movable object forms, and two animate movable object forms The forms include a cup, house, train, car, horse, and girl The specific types of each of these forms used were selected on a basis of simplicity and dissimilarity of form and meaning.

Presentation The general plan of presentation was the same as that used with the geometrical form-board series No help was given the child in the placement of the object forms, with one exception If the child turned a block over in such a position as to make a left-to-right error, the examiner took the block from the child saying, "Here is your block" This procedure was consistently

adhered to throughout the object form-board series both in the A and B series

The Worcester standardization shows that children do not make a right-to-left correction with asymmetrical blocks before age six whereas corrections of inversions are made at earlier ages (2).

If the child stood the block up instead of attempting to make placements, the experimenter took this block from the child and laid it down on the table saying, "No, we don't stand the blocks up You put the blocks in the holes"

Series A. Board 7A was placed on the table with the upper duck and dog forms in regular positions, and the lower duck and dog forms in inverted positions Four blocks, two dog and two duck forms, were placed to the right of the board in positions matching those of the recesses with distances about equally the same. For each subsequent trial the board was turned through an arc of 90 degrees to the right and the position of the blocks made to match that of the recesses. Four trials were given. The position of the third trial was that of the first trial.

Board 8A was presented first with the recesses in the regular position, that is, with the feet of the horse and girl forms next to the child The blocks were placed to the right of the board in similar positions to those of the recesses Two trials were given For the second trial the forms were inverted by turning the board through an arc of 180 degrees to the right and adjusting the position of the blocks accordingly

Series B As an added complication of the object form-board series it was deemed advisable to present the boards a second time with additional blocks from which the correct blocks could be selected. In selecting the additional blocks, the basis was to choose blocks similar in meaning but not necessarily similar in form In Board 7B the chicken and the bear were added, making an additional animal and an additional fowl In Board 8A additional object forms were matched as follows for the cup, the pitcher, for the horse, the cow, for the car, the truck, for the train, the coach, for the house, a different model of a house, and for the girl, a baby.

Instructions to the child in Series B were changed somewhat due to the fact that the child could not place all of the blocks The instructions given for the series were, "You fill the holes."

Board 7B was presented as in 7A except that eight blocks were placed at the right of the board. The four correct blocks were

placed in similar positions to those of the recesses, with the additional blocks adjacent to them. Two trials were given For the second trial the board was turned through an arc of 90 degrees to the right and blocks placed to match.

Board 8B included the set up used in Board 8A with the six additional blocks Positions of correct blocks were matched with those of the recesses In the first trial blocks and board were presented in the regular position and in the second trial in the inverted position.

IDENTIFICATION SERIES

The identification series (Series 9A) incorporated no new elements but rather made use of all the apparatus used in the geometrical and object form-board series. It was given for the purpose of obtaining another measure of form discrimination which might be compared with the form-board performance Two methods of identification were used, one the naming method and the other the identification method. If the child had sufficient linguistic ability and was sufficiently responsive, the naming method was used; if not, the identification method was substituted

With the naming method, the units to be named were placed upon the table and the examiner asked, "What is that?" or "What is this?" The examiner then recorded the name given by the child With the identification method, the units were laid upon the table and the examiner asked, "Where is the duck?" or "Show me the duck" If the child failed to comprehend, the question was repeated. The examiner recorded the form pointed to, whether right or wrong

All pieces in the geometrical and object form series were organized into six groups to be named or identified Groupings were made as follows: (1) blocks for Board 7A, (2) Board 7A, (3) blocks for Boards 5A and 8A, (4) Board 5A, (5) Board 8A, and (6) additional blocks.

SILHOUETTE SERIES

The objectives of this series were: (1) to give another measure of form discrimination, (2) to consider the effect of position in the discrimination of form, and (3) to determine to what extent young children could recognize familiar objects with no other clues than the form silhouettes.

With these objectives in mind, 40 silhouettes (scarlet on white cards) were selected, including the 18 forms used in the geometrical and object form series and 22 additional ones

Selection of the additional 22 forms was purely arbitrary. Forms were selected which might exemplify objects in the child's everyday environment. Both animate and inanimate objects were used. In some cases the same object was presented in different positions to determine the relative importance of meaning as well as consistency. For example, the dog was presented both in a standing and in a sitting position

Presentation. The silhouettes were presented four at a time When one set of four had been designated the cards were removed and the next four presented, and so on throughout the series

Series 10A This included all of the silhouettes presented in the regular position, that is, with the feet of the animal forms next to the child and the head away

Series 10B. The same set of 40 silhouettes was presented as before except that each card was turned through an arc of 180 degrees to the right before being presented. This caused all forms to be in an inverted position

Series 10C. Again the cards were presented as in Series 10A except that each card was turned through an arc of 90 degrees to the right, starting with the Series 10A position.

Goddard Seguin Form-Board Series

The Goddard-Seguin form board was presented in the main experiment in order to make a relative comparison of the three form-board series.

Presentation Two trials were given The position of the board in the first trial was alternately with the diamond recess in the lower left and the upper right-hand corner These positions were alternated with the children For the second trial in either case the board was turned through an arc of 180 degrees to the right In both trials the blocks were placed to the right of the board in a single layer of random order. Instructions were the same as those used in the geometrical form series

Subjects

A total of 174 children ranging in age from two to six years were used in this study Of this number, 80 children were tested in the

preliminary experimentation with the Goddard-Seguin form board Five children, two and three years of age, were used in the preliminary experimentation with the main series of tests. The remaining 89 children were used in the regular series of the study One group, 45 children, was enrolled in the preschool laboratories of the Iowa Child Welfare Research Station, another group, 11 children, was secured from private homes in a small Iowa town, the third group, 31 children, was in residence at the Iowa Soldiers' Orphans' Home at Davenport, Iowa

Of the 89 children given the main experiment 29 ranged in chronological age rather evenly from one year six months to two years six months, and 26 from two years six months to three years six months When the 89 children were grouped in mental-age levels (on the basis of the Stanford-Binet or Kuhlmann-Binet) there were 21 at the two-year level, 29 at the three-year level, 23 at the four-year level, 9 at the five-year level, and 4 at the six-year level No mental test was available on three children Forty-six children were above average, 11 average, and 29 below average. Of the 29 below average, 6 were rated as borderline and 10 definitely feebleminded. No attempt was made to secure a normally distributed group on the basis of intelligence Rather it was desired to study responses from samplings at different levels of mentality

Results

The two- and three-year-old children showed great interest in the test series, particularly in the form boards The four-year-old children showed a lack of interest in some of the simpler boards which were obviously no problem to them Interest usually held throughout the series or until the boards became so difficult that there were continued failures.

Geometrical Form-Board Series

The mean and standard deviation of time and errors by mental and chronological age groups are given in Tables 1 and 2 In comparing the numbers and percentage of successes on the geometric form-board series difficulty gradations are shown in the two-year-old group (Table 3). The highest percentage of successes occurred with Board 1A, the four-circle board. A drop of 8 5% (from 86% to 77 5%) resulted with the presentation of Board 2A with four square forms Whereas 77% were able to complete the boards

TABLE 1
MEANS AND STANDARD DEVIATIONS OF TIME IN SECONDS BY TRIALS FOR THE GEOMETRICAL FORM-BOARD SERIES 1A TO 6A FOR THE CHRONOLOGICAL AND MENTAL AGES, TWO, THREE, AND FOUR YEARS

		Age, years								
		2			3			4		
Board	Trial	Children	Mean	S D	Children	Mean	S D	Children	Mean	S D
					Chronological age					
1A	*a*	25	23.4	13.3	25	12.4	4.3	20	13.2	4.2
	b	25	21.2	11.2	25	13.9	6.5	20	11.5	4.9
2A	*a*	21	22.9	9.7	26	12.8	4.0	21	14.8	9.3
	b	21	22.9	8.0	26	15.3	7.7	21	13.1	8.4
3A	*a*	19	35.0	30.9	24	20.5	11.1	19	11.9	5.8
	b	19	29.5	16.4	24	24.0	18.2	19	15.2	5.2
4A	*a*	12	64.6	26.5	23	39.8	19.0	19	31.2	16.4
	b	12	63.0	27.7	23	41.0	14.2	19	33.7	14.1
5A	1	8	43.3	19.1	23	28.1	17.9	18	13.8	5.4
	2	8	34.0	7.2	23	25.1	13.2	18	14.1	4.3
	3	8	24.8	6.9	23	23.0	10.2	18	16.2	8.8
	4	8	27.6	10.2	23	20.6	8.9	18	14.8	4.8
6A	*a*	6	92.5	41.0	23	47.7	22.5	18	32.8	13.6
	b	6	68.5	21.5	23	54.3	27.4	18	37.8	19.2
					Mental age					
1A	*a*	17	26.2	14.8	29	14.6	4.9	22	12.4	5.2
	b	17	25.2	11.8	29	15.0	6.2	22	11.0	5.2
2A	*a*	16	26.3	12.1	28	15.0	4.6	23	12.3	4.6
	b	16	26.4	8.9	28	16.4	7.3	23	11.7	5.6
3A	*a*	14	36.1	33.5	25	27.0	16.5	23	17.1	11.9
	b	14	28.4	12.8	25	26.2	18.0	23	19.2	13.5
4A	*a*	6	65.0	28.2	26	51.5	22.1	22	33.5	15.2
	b	6	60.0	33.9	26	51.3	19.1	22	37.7	14.9
5A	1	4	53.0	15.9	22	37.0	19.0	21	16.3	7.4
	2	4	31.0	8.0	22	30.5	12.2	21	19.0	7.7
	3	4	26.0	11.1	22	26.0	10.0	21	18.9	8.8
	4	4	32.8	13.2	22	23.4	8.4	21	17.0	5.5
6A	*a*	3	73.3	21.8	21	63.5	34.1	22	40.1	19.2
	b	3	78.0	24.3	21	71.7	29.0	22	41.1	14.0

TABLE 2

MEANS AND STANDARD DEVIATIONS OF ERRORS BY TRIALS FOR THE GEOMETRICAL FORM-BOARD SERIES 1A TO 6A FOR THE CHRONOLOGICAL AND MENTAL AGES, TWO, THREE, AND FOUR YEARS

		Age, years																	
		Chronological									Mental								
		2			3			4			2			3			4		
Board	Trial	Children	Mean	S.D	Children	Mean	S D	Children	Mean	S.D	Children	Mean	S D	Children	Mean	S D	Children	Mean	S D
									Form errors										
3A	a	19	1.47	1.79	24	88	1.17	19	32	68	14	1.50	2.03	25	1.24	1.11	23	48	83
	b	19	95	68	24	1.04	89	19	84	81	14	1.00	43	25	1.24	95	23	95	1.08
4A	a	12	3.90	2.02	24	1.70	1.81	19	1.60	2.38	6	4.00	2.08	26	3.12	2.24	23	96	1.16
	b	12	3.80	1.09	24	2.08	2.18	19	1.70	1.96	6	3.67	94	26	3.54	1.84	23	1.30	1.57
5A	1	8	2.62	1.93	23	1.61	1.88	18	62	1.21	4	2.25	44	22	2.82	1.82	22	36	56
	2	8	3.37	1.79	23	1.65	2.14	18	78	1.99	4	3.50	1.12	22	2.41	2.29	22	42	1.21
	3	8	1.37	86	23	1.61	1.88	18	78	1.65	4	1.50	1.12	22	2.18	2.15	22	64	1.30
	4	8	2.37	1.87	23	1.34	1.31	18	62	1.16	4	3.00	2.55	22	1.86	1.18	22	64	88
6A	a	6	7.33	4.15	23	2.91	3.73	18	1.50	3.40	3	9.67	1.25	21	4.90	4.29	22	82	1.26
	b	6	4.83	2.12	23	3.13	3.89	18	2.28	3.46	3	7.00	2.16	21	5.53	4.19	22	1.27	1.55
									Total errors										
1A	a	25	36	97		0.00	0.00	21	09	.29	18	44	1.12	29	03	17	23	13	45
	b	25	52	94		0.00	0.00	21	.05	22	18	28	56	29	.21	76	23	0.00	0.00
2A	a	21	38	95	26	0.00	0.00	21	05	.22	15	47	1.09	29	03	.17	23	0.00	0.00
	b	21	43	66	26	08	26	21	05	.22	15	.53	.72	29	10	30	23	0.00	0.00
3A	a	19	2.05	2.84	24	1.17	1.49	19	.37	66	14	2.21	3.23	25	1.48	1.42	23	61	1.02
	b	19	1.16	93	24	1.46	1.50	19	1.00	86	14	1.21	94	25	1.60	1.14	23	1.13	1.21
4A	a	12	5.00	3.26	24	1.90	1.95	19	1.80	2.59	6	5.67	3.94	26	3.58	2.32	23	1.09	1.21
	b	12	4.50	1.71	24	2.40	2.30	19	2.05	2.17	6	5.00	2.45	26	3.77	2.14	23	1.57	1.52
5A	1	8	3.00	2.29	23	2.00	2.35	18	61	1.21	4	2.50	87	22	3.32	2.30	22	41	65
	2	8	3.75	2.22	23	1.91	2.41	18	94	1.43	4	3.75	1.30	22	2.91	2.61	22	86	97
	3	8	1.75	1.19	23	1.82	2.27	18	83	1.67	4	2.00	1.58	22	2.36	2.27	22	82	1.33
	4	8	2.50	1.87	23	1.52	1.61	18	66	1.15	4	3.25	2.49	22	1.95	1.26	22	77	1.00
6A	a	6	7.67	3.94	23	3.48	4.56	18	1.67	3.54	3	9.67	1.25	21	5.67	4.87	22	1.00	1.57
	b	6	5.33	2.81	23	3.52	4.55	18	2.39	3.64	3	7.67	2.87	21	6.10	4.24	22	1.36	1.52

TABLE 3

PERCENTAGE COMPARISONS OF MEAN SUCCESS TRIALS ON GEOMETRICAL FORM-BOARD SERIES 1A TO 6A, OBJECT FORM-BOARD SERIES 7A TO 8A AND 7B TO 8B, AND GODDARD FORM-BOARD SERIES FOR THE CHRONOLOGICAL AND MENTAL AGES, TWO, THREE, AND FOUR YEARS

	Age, years																	
	Chronological									Mental								
	2			3			4			2			3			4		
Board	Children	Mean successes	Mean per cent	Children	Mean successes	Mean per cent	Children	Mean successes	Mean per cent	Children	Mean successes	Mean per cent	Children	Mean successes	Mean per cent	Children	Mean successes	Mean per cent
	Geometrical form board series																	
1A	29	25.0	86.0	26	26.0	100.0	21	21.0	100.0	20	18.0	90.0	29	29.0	100.0	23	23.0	100.0
2A	29	22.5	77.5	25	26.0	100.0	21	21.0	100.0	20	16.5	82.5	29	29.0	100.0	23	23.0	100.0
3A	29	20.0	69.0	26	24.0	92.0	21	19.5	92.5	20	14.5	72.5	29	25.5	87.5	23	23.0	100.0
4A	29	12.5	43.0	26	24.0	92.0	21	19.0	90.0	20	6.5	32.0	29	26.0	89.0	22	22.0	100.0
5A	29	12.0	41.0	26	23.7	91.0	21	18.5	88.0	20	7.0	35.0	29	24.0	83.0	21	21.0	100.0
6A	29	7.5	26.0	26	23.0	88.0	21	18.0	85.0	20	3.5	17.5	29	22.0	75.5	22	22.0	100.0
	Object form board series																	
	Series A																	
7A	27	1.5	5.5	26	20.0	76.0	20	17.5	87.5	20	1.3	6.3	27	15.0	56.0	22	21.0	94.0
8A	26	.5	2.0	25	21.0	81.0	19	15.5	81.5	20	0.0	0.0	27	15.0	55.5	21	20.0	95.0
	Series B																	
7B	26	0.0	0.0	22	16.0	62.0	18	13.5	74.5	20	0.0	0.0	19	11.5	60.5	18	18.0	100.0
8B	26	0.0	0.0	22	9.5	43.0	18	12.0	66.0	20	0.0	0.0	22	5.0	23.0	19	14.5	76.0
	Goddard form-board series																	
	15	.5	3.5	20	14.5	72.5	18	14.5	80.0	11	0.0	0.0	21	12.0	58.0	17	16.5	97.0

having both forms separately, only 69% were able to complete Board 3A, incorporating the two forms in one board.

A striking drop occurred between Board 3A and Board 4A. In Board 3A there are two circle and two square forms. In Board 4A the only change was doubling the forms. On Board 3A 69% of the two-year-old children succeeded and on Board 4A only 43%, making a drop of 26%.

With the addition of two different forms on Board 5A a fourth drop took place. Of the two-year-old children 41% succeeded on Board 5A as against 69% on Board 3A.

In Board 6A, which is similar to Board 5A except that here again each unit has been doubled, another striking drop is apparent. Whereas 41% completed Board 5A only 25% completed Board 6A, making a drop of 16%.

However, the three-year-old performance shows different results. All succeeded on Boards 1A and 2A. On both Board 3A and Board 4A, 92% succeeded (showing no drop where units were doubled). Similarly, there was no drop from Board 5A to Board 6A. Results for the four-year level substantiate those for the three-year level.

Similar comparisons for mental-age groups are also given in Table 3. The results show similar differences only in a more marked degree. In the two-year-old group there were 18% and 10% more successes on circles and squares presented separately than when presented together in Board 3A. Doubling the units on Board 4A brought about an even greater drop for the mental age group (from 72% to 32%). A similar drop also took place between Board 5A and Board 6A.

At the three-year level negligible drops occurred when the units were doubled. The four-year-old children were 100% successful throughout the series.

Percentile tables in decile units were worked out for both mental and chronological age groups in terms of successful trial time averages, errors, incompletes, and failures.[8]

Correlations for the boards of the geometrical and object form series with mental and chronological age are given in Table 4. The correlation of chronological age with mental age for the entire group was $.692 \pm .045$. Correlations on total errors of successes are higher with mental age than with chronological age.

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[8]These data are on file at the Iowa Child Welfare Research Station.

TABLE 4

Coefficients of Correlation and Probable Errors in Geometrical Form-Board Series 3A to 6A, Object Form-Board Series 7A to 8A and 7B to 8B, and Goddard Form-Board Series between Chronological Age with Time and Errors in Trial A, Mental Age with Time and Errors in Trial A, Time with Errors in Trial A, Time with Trial B in Trial A, and Errors with Trial B in Trial A

	Trial A						
	Time		Errors		Time		Errors
	Age						
Board	Chronological r PE.	Mental r PE	Chronological r PE	Mental r PE	Errors r PE	Trial B r PE	Trial B r PE
3A	—421± 070	—406± 072	—354± 075	—361± 075	556± 059	428± 070	202± 082
4A	—476± 071	—619± 057	—377± 079	—634± 055	757± 039	666± 051	689± 048
5A	—520± 070	—528± 069	—.357± 084	—622± 059	782± 038	326± 086	532±.069
6A	—617± 061	—542± 070	—397± 082	—580± 065	831± 030	630± 059	783± 038
			Object form-board series				
			Series A				
7A	—456± 097	—567± 083	—298± 112	—684± 065	872± 029	308± 111	.585± 081
8A	—510± 085	—352± 101	—284± 106	—410± 096	761± 049	603± 074	643± 068
			Series B				
7B	—422±.103	—376± 107	—270± 116	—439± 101	626± 076	471± 097	374± 107
8B	—.490± 118	—561± 105	—446±.124	—531± 107	905± 028	585± 102	544± 109
			Goddard form-board series				
	—.510± 099	—669± 073	—324± 118	—422±.109	585±.087	813± 045	840± 039

The correlations of time with total errors range from $.556 \pm .059$ on Board 3A to $.905 \pm .028$ on Board 8B. In general, children taking longer periods of time also make greater numbers of errors.

Reliabilities in terms of the correlation of Trial A (first success) with Trial B (second success) are higher for both time and total errors in boards where units have been doubled.

Object Form-Board Series

Very few two-year-old children were able to succeed with the object form boards. One cause for this was the fact that the blocks were asymmetrical and could be placed in only one position. Only three two-year-old children succeeded on two out of four trials on Board 7A. These successes occurred on trials in which the recesses were in regular and inverted positions. Failures ensued with the forms sidewise (Table 3).

A similar type of performance occurred with the three-year-old group on Board 7A. Fewer children were successful on the inverted position (second trial) than on the regular position (first trial). The four-year-old children showed a similar drop for the second trial. More children succeeded on the fourth trial than on the second trial.

Increases in mean time for successes at the three- and four-year age levels are shown from the first trial and the second trial in Board 7A. Similar increases are shown in the mental-age group of three-year-old children. However, the standard deviations were so high that the mean differences are probably not significant.

A comparison of errors showed an increase in number of errors for the second and fourth trials in Board 7A as against the first and third trials for the three-year mental- and chronological-age groups.

Board 8A shows a drop in percentage of two-year-old children completing as compared with Board 7A. The three-year-old group also showed a drop in percentage of successes between the regular position (first trial) and the inverted position (second trial). Similar results are shown in Table 3 for mental-age groups.

On Board 8A an increase of time occurred between the first and second trials for both three- and four-year-old children in both the chronological- and mental-age groups.

While time for both chronological- and mental-age groups for three-year-old children increased from the first to the second trial

on Board 8A, form errors (attempting to place a block in unlike form recesses) decreased

The first trial of Series B of the object form boards shows a *marked increase in time and errors due to the addition of extra* blocks.

Identification Series

Of 15 two-year-old children who were presented the identification series only 9 were able to identify either by pointing or naming Of the 9 only 4 named correctly form units for Board 7A and 6 named correctly four or more forms in Board 8A

Nine three-year-old children out of 18 named four or more forms in Board 8A. Eight of these named the forms in Board 7A

Ten four-year-old children out of 18 named four or more forms in Board 8A and 8 named all four form representations in Board 7A

The cup form was missed consistently by most children in both the identification and silhouette series. It apparently was not a good representation.

None of the children at any age level could identify correctly all form units of the geometrical form-board series A few of the older children named the circle and the square.

Silhouette Series

Only 9 two-year-old children out of 15 presented the series were able to indicate silhouette forms either by naming or identification *It appears from the results that some forms were discriminated* and named correctly by a large percentage of the children. Certain forms tended to be named consistently whereas others did not There is, however, a positive relationship between high consistency percentages and high percentages for correct naming Percentages tend to run higher when Series 10C (sidewise position) is omitted

Summary and Conclusions

It was the purpose of this study to investigate experimentally certain factors related to form-board performances of a group of two- and three-year-old children. Major factors considered include. (*a*) form discrimination, (*b*) variations in meaning, (*c*) positional elements, (*d*) *number complexity,* and (*e*) *comprehension of relationships*

Five series of experiments were used, including four series of

form boards and one of silhouettes. Form-board series include six geometrical form boards of increasing difficulty, two object form boards, and an identification test on all form boards. The silhouette series includes 40 silhouette forms presented four at a time in each of three positions, regular, inverted, and sidewise. In form-board series increased complexity was made by addition of new forms and increasing numbers of similar forms.

Eighty-nine children ranging in age from two to six years have been used in the main study. Of this number 29 ranged in age rather evenly from one year six months to two years six months, and 26 from two years six months to three years six months.

The most significant results are summarized as follows:

1. With two-year-old children there was a decrease in the number of successes in both instances where form units were doubled, whereas no decrease occurred with the three-year-old children.

2. The series of geometrical form boards used in the present study show applicable gradations for two- and three-year-old children.

3. The two-year-old children frequently identified objects, both in recess and block forms, while failing to see the relationship between block and hole.

4. At the two-year age level form boards are not valid measures of form discrimination. This is shown by the high frequency of form errors following an unsuccessful attempt to place the block in its proper recess.

5. Children of all ages can place geometrical forms without being able to identify them by name.

6. More persistence was evidenced in the face of failure with the object form boards than with geometrical form boards.

7. The object form boards are too difficult for two-year-old children but are suitable performance tests for three-year-old children.

8. Reliability was higher when form units were doubled both for time and errors.

9. Both geometrical and object form boards correlate higher with mental age than with chronological age. Mental-age correlations with time range from $-.352 \pm .101$ in Board 8A to $-.619 \pm .057$ in Board 4A; with errors from $-.361 \pm .075$ in Board 3A to $-.684 \pm .065$ in Board 7A.

10. The sidewise position of elements on Board 7A was more difficult than the inverted and regular positions.

11 Inversion of position on Board 8A tended to cause more mechanical errors with three-year-old children but not an increase of form errors.

12 Changes in position on geometrical form boards made little difference on test results at any age level.

13. The Goddard-Seguin form board is too difficult for two-year-old children but is applicable at the three- and four-year age levels

REFERENCES

1 GODDARD, H H The form board as a measure of intellectual development *Tr. School Bull*, 1912, 9, 49-52

2 SHAKOW, D, & KENT, G H The Worcester Formboard Series *Ped Sem*, 1925, 32, 599-611

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UNE ÉTUDE DE QUELQUES FACTEURS QUI INFLUENCENT LES ACCOMPLISSEMENTS DES ENFANTS ÂGÉS DE DEUX ET DE TROIS ANS AVEC LE FORM BOARD

(Résume)

Le but de cette etude, c'est d'étudier expérimentalement et analytiquement la relation entre la discrimination des formes, la variation de signification, les éléments de position, la complexité des nombres, et la compréhension des relations, et les accomplissements d'un groupe d'enfants âgés de deux et de trois ans avec le Form Board (Tableau de Formes)

On s'est servi de deux séries de Form Boards variant en difficulté, une serie de silhouettes, et le Form Board Goddard-Seguin La première serie de Form Boards se compose de six tableaux de formes géométriques La seconde série inclut quatre tableaux de formes-objects animées et inanimées Les silhouettes incluent les dix-huit formes employées dans les Form Boards et vingt-deux autres

On a employe dans cette étude cinquante-cinq enfants variant en âge d'un an six mois à trois ans six mois, evec en outre un groupe de vingt enfants de quatre ans

Les résultats indiquent que les Form Boards ne sont pas de justes mesures de la discrimination des formes au niveau d'âge de deux ans Chez les enfants de deux ans, le nombre des reussites est devenu plus petit quand on a double les unites de formes geométriques, tandis que ceci n'arrive pas chez les enfants de trois ans Les enfants peuvent placer des formes géométriques sans savoir les nommer, tandis qu'ils peuvent nommer les formes-objets sans les placer. Les tableaux de formes-objets employes ont été trop difficiles pour les enfants de deux ans mais ont eté de bons tests d'éxécution pour les enfants de trois ans. Les positions obliques des eléments ont été plus difficiles que les positions à l'envers ou les positions ordinaires

SKEELS

EINE UNTERSUCHUNG EINIGER DER FAKTOREN DIE AUF DIE LEISTUNGEN VON ZWEI- UND DREI-JAHRALTEN KINDERN AN FORMBRETTERN (FORM BOARDS) EINWIRKEN

(Referat)

Der Zweck dieser Studie war, die Beziehung der Formenunterscheidung (form discrimination), der Bedeutungsverscheidenheit (variation in meaning), der Lage, der numerischen Verwicklung, und des Verstandnisses fuer Zusammenhangen zu den Formbrettleistungen einer Gruppe von zweiund drei-Jahr-alten Kindern experimentell und analytisch zu untersuchen

Man benutzte zwei Formbrettserien von graduirter Schwierigkeit, eine Silhouettenserie, und das Formbrett von Goddard-Seguin Die erste Formbrettserie besteht aus sex Brettern mit geometrischen Formen Die zweite Serie enthalt vier Bretter mit den Formen von belebten und unbelebten Gegenstanden Die Silhouetten bestanden aus dn achzehn Formen, die in den Formbrettern gebraucht wurden, und ausserdem noch zwei-und-zwanzig Formen

Als Versuchspersonen dienten 55 Kinder im Alter von 1½ bis 3½ Jahren und eine Erganzungsgruppe bestehend aus 20 vierjahrigen Kindern

Die Befunde weisen darauf hin, dass Formbretter nicht gultige Masstaben der Formenunterscheidung auf dem Niveau des zwei-jahrigen Kindes darstellen Bei zweijahrigen Kindern zeigte sich eine Verminderung der Zahl der guten Erfolge wenn die geometrischen Formeinheiten verdoppelt wurden, wahrend sich bei drei-Jahr-alten Kindern keine Verminderung zeigte Kinder sind im Stande, geometrische Formen richtig unterzubringen (place) ohne sie bei Namen nennen zu konnen, und anderseits werden Formgegenstande manchmal richtig genannt und doch nicht untergebracht Die Formbretter die unbelebte Gegenstande enthielten fielen den zweijahrigen Kindern zu schwer, eigneten sich aber als Leistungsprufungen (performance test) fur die drei-jahrigen Kinder Seitliche Lagen (sidewise positions) der Bestandteile waren schwieriger als umgekehrte oder gewohnliche Lagen

SKEELS

THE NON-RANDOM CHARACTER OF INITIAL MAZE BEHAVIOR*

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Maze learning by rats is usually defined as improvement over the initial behavior in the maze. While many studies have been made of the factors affecting maze learning, there has been very little interest in the initial behavior from which learning begins

HISTORICAL

By way of historical introduction we shall review two theories of initial behavior in the maze These theories are not essentially incompatible with each other. One holds that the rat on its first run in the maze makes all, or nearly all, possible errors Woodworth, for instance, says. "The rat placed in a maze explores He sniffs about, goes back and forth, enters every passage, and actually covers every square inch of the maze at least once" (11, p. 132) Whether this thorough exploration results from random or from non-random activity, the author does not say The same type of description occurs in the first paper on the white rat in the maze Small says: "In the first trial the rats invariably traversed practically all the galleries ." (5, p. 233) However, the detailed record of one first run, the only record of a complete first run presented by Small, shows that the rat failed to enter two of the seven blind alleys.

Few experimenters have been interested in noting whether the rat on its first run does or does not enter blind alleys excessively, but, by examining published data we find that the statement that every square inch of the maze is covered is inaccurate In Peterson's presentation (3) of his data on learning in 24 white rats the errors of the first two runs are grouped together, but the 24 rats made only 14 errors in Cul-de-sac 7 during these two trials, which means that at least 10 rats, and very probably more than 10, never entered this cul-de-sac on the first trial Stone (6) presents a graph which shows that the average number of errors in the forward

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direction on the first run in a Carr maze of 10 blinds was only 1.8, or less than one-fifth of the minimum number of opportunities to enter blind alleys. Stone and Weaver (8) show, regarding the 12-unit multiple-T maze described by Stone and Nyswander (7), that for three blinds the average number of errors per rat in Trials 1 to 5, inclusive, is less than one, which means that some animals failed to enter each of these blinds not only during the first run but during the first 5 runs. Dashiell's (1) study of the first run also reveals that not all blinds were entered. The data of Warden and Cummings (9) show that in their maze nearly every alley was omitted by one or more rats on the first trial. We have not tried to find additional evidence in the literature.

A second hypothesis concerning initial behavior is that it follows the laws of chance, in short, that when presented with alternatives, the rat selects them equally. This was proposed by Watson (10). Peterson (4) has shown mathematically that activity of this kind will finally take an animal through the maze and will account for the preponderance of errors in the first part of the maze. Dashiell (1) found that the chance choices occurred in some maze alternatives but not in others, but he did not separate the first presentation of an alternative from other presentations within the first run, and his percentages are not very reliable on account of small numbers. Stone's graph (6) showing that only one-fifth of the blinds were entered in a forward direction has been cited, the chance proportion here would be one-half. Peterson (3), dealing only with behavior upon emergence from a blind alley, found that rats during the first two trials returned about 40% of the time and went forward 60% of the time. He is of the opinion that on the first occasion the 50-50 ratio would have held.

Experimental Section

Apparatus, Subjects, and Procedure. In this experiment a block elevated maze devised by the senior author and described elsewhere (2) was used. It consisted of an elevated pathway formed by setting wooden blocks on a level floor. The blocks were 1¾" wide, 12" high, and 24" long. The pattern used is shown in Figure 1. It is a multiple-T zigzag pattern, requiring a simple right-left alternation of direction, with 13 units of true pathway and 12 units which were blind alleys. In Figure 1 the true pathway units are numbered and the blinds are lettered. The blocks were new and the maze was unused at the beginning of the experiment.

Fifty-nine normal untrained white rats, about 3 months of age, were used in the experiment Ten of the rats were given food in the food box for two days prior to their first run The remaining 49 were given no preliminary feeding but were deprived of food for 24 hours prior to their first run in order to make them more active. Since there were no reliable differences in the behavior of the two groups, their results will be presented together.

Each rat was given an opportunity to explore the maze, and one or both of the experimenters observed the behavior from behind the screen indicated in the drawing. The rat was put down on Block 1. Any rat which reached the food box was removed as soon as it arrived there. As some rats require an exorbitant amount of time to complete a run, a time limit for exploration had to be fixed The rule adopted was as follows Each rat was left on the maze at least

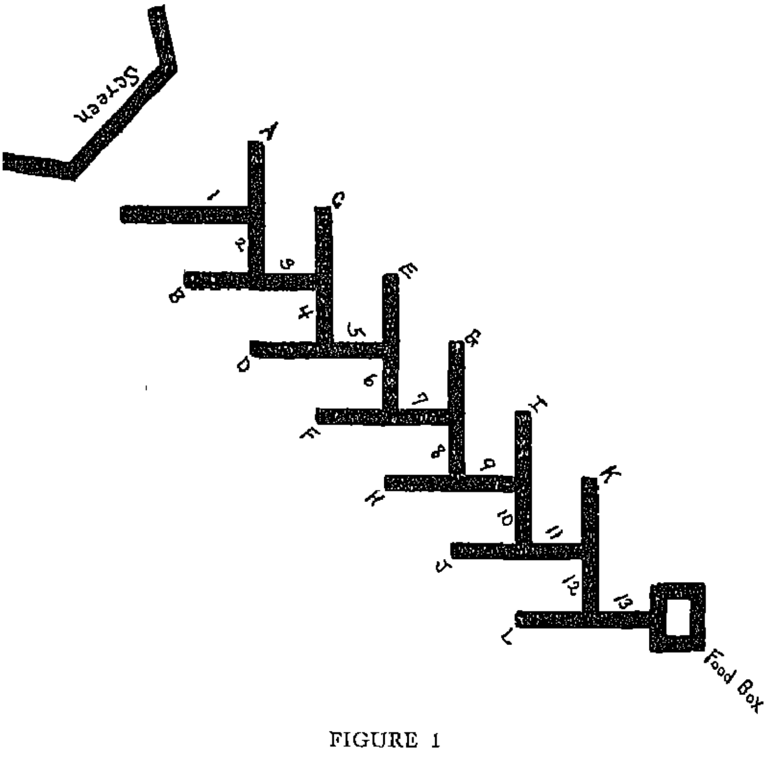

FIGURE 1

3 minutes unless the food box was reached in less than that time, and it was removed when, after 3 minutes time, it became inactive. No rat remained on the maze more than 11 minutes

A pan filled with a dry mixture of graham flour and powdered milk was present in the food box at all times. We mention this only for the sake of completeness, for it is doubtful that the pan had any influence upon the rats.

Results Twenty-one rats reached the food box, 18 explored beyond Block 4 but did not reach the end of the maze, 15 went beyond the first unit of the true pathway but did not go beyond Block 4, and 5 rats did not leave Block 1. These groups of rats will be treated separately in the order in which they are listed above That these groups exhibited a real difference in behavior and not merely a difference in the amount of time during which they were allowed to explore is shown by the fact that the first group, consisting of the rats which went the entire length of the maze, spent the least time on the maze The average time spent on the maze by these rats was only 3 minutes The second group averaged 6 3, which is the highest group average, the third group averaged 3 5 minutes, and the completely inactive group averaged 5 minutes

The outstanding characteristic of the first group was the decidedly non-random character of their initial behavior in the maze *Two of them went from entrance to food platform without entering a single blind alley or retracing a single unit of the true pathway. By chance one would expect one rat in about twenty-five million to perform this feat* Behavior was recorded in terms of the blocks which were entered and a block was considered to have been entered when both fore feet of the rat were upon it In leaving Unit 1, the chance of entering the true pathway is ½. From Block 2 through Block 12, there are four ways of leaving such unit of the true pathway (forward into the next true pathway unit, forward into a blind, backward into the previous true pathway unit, and backward into a blind) so that the chance of going forward correctly from any block is ¼ On Unit 13 the chances of taking the true pathway forward is 1/3. The expectancy of any rat of going correctly through all 13 blocks is the product of the fractions or 1 in 25,165,824 (Neither of these two rats had been given preliminary feeding.)

It may be argued that we should not allow equal probabilities of going forward and returning because the rat does not actually return from half of the blocks But that is simply stating the facts

and refusing to compute their chance expectancy For the rat is free, as far as the external situation is concerned, to take any one of the possibilities that we have mentioned as offered by the blocks. If the rat does not select the possibilities with equal frequency, it is not behaving in a random fashion. It may be of interest to add that, if the rat were somehow prevented from returning, the chance of avoiding all blind alleys would still be only one in 4096.

The record of this first group as a whole was only slightly less remarkable than that of the two rats just discussed Two rats made only one-third of them.

However, we are chiefly interested not in the total errors but in only one error each, two more made only two each; a total of 11 rats each made no more than 4 entrances into culs-de-sac The greatest number of total entrances into blind alleys was 10, while the average number was 4.5. In other words, not a single rat entered all culs-de-sac on the first run, and the average rat entered the direction taken by the rat in leaving each unit of the maze *for the first time*. We shall not study the direction taken by the rat when leaving a block for the second time because we wish to confine ourselves to initial behavior. As a matter of fact, the number of blocks from which the rats progressed a second time during the first trial are too few for statistical analysis.

Let us consider first the direction taken in leaving each unit of the true pathway for the first time Since 21 rats progressed through each of the 13 true-pathway units, there were a total of 273 pieces of behavior exhibited on units of the true pathway which the rats had not previously entered. From each unit the rats could either return toward the starting alley or go forward (Block 1 is an exception to this, as the rats could go only forward from it); in fact the rats went forward 260 times and returned only 13 times. In going forward or backward from a true-pathway unit the rats had to take either a true pathway unit or a blind-alley unit In going forward the true-pathway units were taken in 196 cases in comparison with 64 cases of selection of blinds. In returning, 5 chose the true pathway and 8 chose blinds. With the exception of the last figures cited, behavior was reliably different from chance expectation in all cases. It is obvious that the 21 rats which reached the food box went forward and avoided errors in previously untraveled sections of the maze in a manner that cannot be attributed to chance.

Behavior on emerging from first entrances into a blind alley may

be analyzed in the same way. There were 88 such entrances In 66 cases the rats in emerging from the cul-de-sac went forward, in 22 they returned toward the entrance

The 18 rats whose exploration extended beyond the fourth unit of the true pathway but which did not reach the food box also avoided errors and returns in a non-random fashion, but not as decidedly as the group just described. No rat of this group went to the farthest point which it reached without error and without retracing. Although the average unit of true pathway reached by this group was only Unit 6, or the mid-point of the maze, the average number of errors was 6.4 in contrast to 4 5 for the group which explored the entire maze

The choices following initial entrance into true pathway units were 107 in number Ninety of these were in a forward direction, 17 were returns Of the forward choices, 54 were into true pathway units and 36 into blinds Of the returns, 13 were into blinds and only 4 were into true-pathway units.

Of choices upon emerging from initial entrances into blinds, which were 74 in number, 45 were forward, 29 were backward in direction

The third group of rats, consisting of those animals which moved from Block 1 but which did not pass beyond Block 4, made choices from only 30 new units of true pathway Of these, 26 were forward choices, 4 were backward. Sixteen of the former and all of the latter were into blinds. Of 22 first emergences from blinds, 9 were forward movements and 13 were backward in direction

The group which did not explore at all obviously does not concern us here

The fact presented above may be summarized as follows: In 410 initial choices from true pathway units, made by 54 rats (5 rats were inactive), the forward direction was taken in 376 cases, the backward direction in only 34 In going forward, the rats chose the true pathway in 260 cases, the blinds in 116 cases In returning, the true pathway was chosen only 9 times, the blinds 25 times. In other words, from true pathway units first entered the rats went forward in over 90% of the cases In going forward, the true pathway was selected approximately 70% of the time, while in returning it was selected only 25% of the time With the exception of the last one quoted, these percentages are highly reliable and differ reliably from chance expectations. In 184 initial emergences

from blinds, a forward direction was taken in 120 cases and a backward direction in 64. These numbers, too, are reliably different from chance

In the foregoing data there is some indication that the more active rats were the more non-random or directed in their behavior. For instance, the true-pathway selections among the initial forward movements were 75%, 60%, and 37% of the total choices in the first, second, and third groups, respectively. However, these percentages may differ only because the groups explored different sections of the maze The rats of Group I chose the true pathway only 65% of the time in going forward from Blocks 1-7 but chose it 79% of the time in leaving Blocks 8-13 in a forward direction. The 65% record is not far different from the 60% record of the second group, which, on the average, reached Block 6 The 37% record of the third group rests upon inadequate numbers. Without presenting in detail other such comparisons, we may say that there is not conclusive evidence of group differences, but that the groups are too small for adequate conclusions. While we have felt it necessary for the sake of completeness to present the data for each group separately, the agreement among the groups is more striking than the disagreement

Discussion

In this study we have presented evidence, corroborative of that cited in the historical section, that not all parts of a maze need be covered by the rat on its first run. In addition, we have shown that in the present maze situation rats do not behave in a random manner during the first run. Errors and retraces occurred much less often than we should expect on a chance basis. Not least important is the finding that it is possible for a rat to run a maze perfectly when placed upon it for the first time. Nevertheless, we wish to state explicitly that we do not hold that non-random behavior or initial perfect runs can occur in *all* mazes.

We are not able at this time to explain the behavior which we have found A directional stimulus in line with the general direction of the true pathway may have kept the rats in the correct direction; the visual appearance of the blind alleys may have inhibited errors, or the rats may have quickly learned the right-left movement of the maze pattern from the first few errors and successes. Which one of these conditions or of other conditions here unmentioned actually controlled the rats' behavior our present data cannot tell. We should

point out, however, that our experimental conditions were in no way exceptional, and that as far as we know, it is quite possible for non-random behavior to occur in mazes other than the one here used

The fact that non-random behavior does occur in mazes has, it seems to us, definite implications In the first place, it indicates that learning data, which are improvement data, may give a very incomplete account of the mastery of a maze It is demonstrated that some mastery, even complete mastery, may be present in the first run. In order to show the complete course of adjustment, should not the number of errors to be expected by chance be first presented on the graph, with the learning curve following this?

In the second place, it indicates that theories of maze mastery must deal not only with the elimination of errors which have been made by the animal but also with the total avoidance of some errors We have shown that many errors are avoided on the first run The total learning records of ten rats, not presented here, show that practically every rat masters the maze without ever having entered several of the culs-de-sac The traditional problem of maze learning has been the explanation of the elimination of errors This experiment raises a new question the explanation of the avoidance of errors.

Summary

Fifty-nine white rats were allowed the freedom of a simple-alternation multiple-T elevated maze for a restricted period of time The rats were untrained and no preliminary feeding was given the majority of the rats Two of the rats went from the entrance to the exit of the maze without error and without retracing All of the rats which explored behaved in a non-random fashion, in that they retraced and made errors much less often than one would expect by chance The data show clearly that initial maze behavior need not be random and that it is not always characterized by excess movements as is implied in many descriptions of initial maze behavior It is pointed out (*a*) that maze studies tend to neglect the initial adjustment as a factor in maze mastery, and (*b*) that the avoidance of errors, as well as the elimination of errors, demands an explanation.

References

1 Dashiell, J F The need for analytical study of the maze problem *Psychobiol*, 1920 2, 181-186

2 Dennis, W A block elevated maze *J Comp Psychol*, 1931, **12**, 429-432

3. PETERSON, J. The effect of length of blind alleys on maze learning. *Behav Monog.*, 1917, No. 15 Pp 53.
4. ———— Frequency and recency factors in learning by white rats *J Anim. Behav*, 1917, **7**, 338-364.
5. SMALL, W. S An experimental study of the mental processes of the white rat *Amer. J Psychol*, 1901, **12**, 206-240.
6. STONE, C P. The reliability of a modified Carr maze. *J. Genet. Psychol*, 1928, **35**, 507-522.
7. STONE, C. P, & NYSWANDER, D B. The reliability of rat learning scores from the multiple-T maze as determined by four different methods *J. Genet Psychol*, 1927, **34**, 497-524
8. STONE, C P, & WEAVER, H. E. The relative ability of blind and normal rats in maze learning *J. Genet Psychol*, 1928, **35**, 157-177.
9. WARDEN, C J., & CUMMINGS, S. B, JR Primacy and recency factors in animal motor learning. *J Genet Psychol*, 1929, **36**, 240-256
10. WATSON, J. B Behavior. An introduction to comparative psychology New York Holt, 1914 Pp 439
11. WOODWORTH, R W Psychology. (Rev. ed) New York Holt, 1929 Pp 590

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LE PREMIER COMPORTEMENT DANS LE LABYRINTHE EST-IL AU HASARD?

(Résumé)

On a permis à 59 rats blancs d'entrer dans un labyrinthe élevé multiple-T à alternation simple pendant un temps limité. Les rats n'ont pas été entraînés et la plupart n'en ont pas reçu de nourriture préliminaire Deux des rats sont allés depuis l'entrée jusqu'à la sortie due labyrinthe sans erreur et sans retracement. Tous les rats qui sont entrés se sont comportés d'une façon non au hasard, parce qu'ils ont retracé et ont fait des erreurs beaucoup moins souvent que ce qui arrivait au hasard Les donées montrent clairement qu'il n'est pas nécessaire que le premier comportement dans le labyrinthe soit au hasard et qu'il n'a pas toujours des mouvements non nécessaires, comme beaucoup des descriptions du premier comportement dans labyrinthe suggèrent. On montre (1) que les études du labyrinthe tendent à négliger l'ajustement initial comme facteur dans l'apprentissage du labyrinthe, et (2) que l'action d'éviter les erreurs aussi bien que l'élimination des erreurs exige une explication.

DENNIS ET HENNEMAN

DIE NICHT-ZUFALLIGE ART DER ANFANGLICHEN TATIGKEIT IN EINEM LABYRINTH

(Referat)

Es wurde 59 weissen Ratten erlaubt, sich wahrend einer bestimmter kurzen Zeit in einem einfachen alternierenden erhohten multiplen T-Labyrinth (simple alternation multiple-T elevated maze) frei zu bewegen Die Ratten waren nicht dressiert worden und wurden nicht vorgangig gefuttert Zwei der Ratten liefen vom Eingang direkt zum Ausgang des Labyrinthes, ohne Irtum und ohne Wiederbetretung ihres Pfades. Alle Ratten die auskundschafteten (explored) erwiesen eine nicht-zufallige Tatigkeit insofern sie viel seltener Irrtumer machten als man dem Zufall nach erwarten wurde Die Befunde weisen deutlich darauf hin, dass anfangliche Labyrinthtatigkeit nicht zufallig zu sein braucht, und dass sie nicht immer durch ubermassige Bewegungen gekennzeichnet wird, wie in vielen Schilderungen der anfanglichen Labyrinthtatigeit angedeutet wird Es wird darauf hingewiesen, (1) dass man in Untersuchungen an Labyrinthen geneigt ist, die anfangliche Anpassung als Bestandteil der Bemeisterung des Labyrinthes zu vernachlassigen, und (2) dass die *Vermeidung* von Irrtumern sowohl wie die *Ausschaltung* von Irrtumern Erklarung erfordert

DENNIS UND HENNEMAN

STABILITY OF MENTAL TEST RATINGS FOR PRESCHOOL CHILDREN*

From the Children's Bureau of Pennsylvania

DOROTHY K HALLOWELL

Mental tests for children of school age have been evaluated over a long enough period to convince us of their prognostic worth Tests for children of the preschool group are, on the other hand, so much more in their infancy, in fact, barely out of the experimental stage, that their reliability is open to much more question, consequently, any data on retests that can be gathered seems valuable to report.

In 1928 the writer published a series of test norms for children from 12 to 47 months. Further study with this age group has been possible and a series of examinations have been made which show how reliable an initial diagnosis on an infant or preschool child may be This report concerns 436 children, all examined by the writer The method employed in studying this material has been to compare the diagnoses made on the first examination with those made on the last examination Comparisons of this sort enable us to determine how much reliance can be placed on an initial examination made at an early age.

In most cases the purpose of any individual study is to help in understanding and making plans for the child There may be a behavior problem to help correct There may be some unfortunate environmental situation which requires the child to be removed from his own parents and cared for by strangers The most crucial of such circumstances is that where the break must be permanent and where, therefore, legal adoption is to be considered as the plan offering the child the best substitute for a satisfactory life with his blood parents. As a protection to both the foster parents and to the child, and for the happiness of both, it is most desirable to know the intelligence level of the child, as well as his physical equipment, family background, and personality make-up For many years it has been possible to determine what a child's physical condition is, and,

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through careful inquiry, the possible hereditary traits which may appear, such as insanity, feeblemindedness, or predisposition to physical disease. However, the most recent studies in human biology are giving us a new viewpoint and are making us less certain as to how heredity in an individual case will work. At least as far as mentality is concerned, it has been shown that we are not justified in accepting or rejecting a child because of his parentage. It has been definitely established that feeblemindedness can appear in a family where all the other members are normal or even superior, and that, on the other hand, normal or bright children can have a feebleminded or very dull parent. For these reasons it seems that the best procedure is to study, as carefully as science permits, the child for the individual that he is, and thereby try and determine what his own potentialities are to be.

The Children on Whom This Study is Based

(*a*) They were in age at time of first test from 3 months to 47 months, divided, with 20% under 1 year, 30% from 1 to 2 years, 30% from 2 to 3 years, and 20% from 3 to 4 years. (See Table 1.)

(*b*) At time of last examination they were in age from 12 months to 8 years, with the greatest number being between 3 and 4 years. No child was included where the interval between the tests was less than 6 months nor where the child was under 12 months on the last test. (See Table 2.)

(*c*) The children were, except for a 4% group, social agency cases. Eighty-one per cent were in foster homes, under the care of the Pennsylvania Children's Aid Society, and Philadelphia Children's Bureau. Fifteen per cent were in day nurseries or institutions in Philadelphia. Four per cent were private cases, children who had always lived in their own homes, and who were not tested because

TABLE 1

Ages of Children Tested—At Time of First Examination

Age in months	Number of cases	Percentage
Under 12	86	20
12-23	130	30
24-35	131	30
36-47	89	20
	436	

TABLE 2
AGES OF CHILDREN TESTED—AT LAST EXAMINATION

Age in years	Number of cases	Percentage
1-2	59	14
2-3	83	19
3-4	104	24
4-5	80	18
5-6	55	13
6-7	36	8
7-8	9	2
8-9	10	2
	436	

they presented any problems. A good control study would be one of a large group of children who have lived always with their own families From the number of foster children whose diagnoses improved after a period in a better environment, the writer believes it is quite probable that an unplaced group with a consistently desirable and stable background would show even a higher percentage of constancy than the present study reports.

TEST MATERIAL

With children under 12 months, the basis of judgment was entirely by the Gesell standards. From 12 to 47 months the Gesell tests were supplemented by the performance tests standardized by Hallowell, by the Stanford revision of the Binet tests when the child had sufficient language development to make their use possible, and by certain of the Stutsman tests For retested children over 4 years, the Pintner-Paterson Scale of Performance Tests was also used

Because of the time interval between tests, there did not seem to be enough memory hang-over to raise the diagnostic rating, even though the same general test material was used Usually, because the child was older, some new and more difficult material was introduced.

About half of the children were tested in the homes where they were living at the time, and the other half were seen in the writer's office When possible, an adult well known to the child was present, so that the strangeness of the situation would not interfere with the naturalness of response

As previously stated every child had at least two tests, and a few as many as eight (See Table 3)

TABLE 3
NUMBER OF TESTS GIVEN

Number of tests	Number of cases	Percentage
2	237	54
3	124	28
4	47	11
5	19	5
6 or more	9	2
	436	

TABLE 4
INTERVAL BETWEEN FIRST AND LAST TEST

Interval	Number of cases	Percentage
6 mos to 1 yr	120	27
1-2 yrs	160	37
2-3 yrs	60	14
3-4 yrs	52	12
4-5 yrs	31	7
5 and more yrs	13	3
	436	

The smallest interval between the first and last test was six months, the greatest, seven years, with the median time from one to two years. (See Table 4.)

DIAGNOSTIC TERMINOLOGY

In reporting diagnoses statistically for this study, it has seemed practical to use numerical ratings Although a diagnosis of general ability cannot be estimated to the exact numerical point in the same way as an IQ score by tests such as the Binet, still a numerical rating is quite possible In reporting my cases to the social agencies who were caring for these children, ratings were given such as developmental quotient 90 or 95, rather than 93 or 91, that is, not laying stress on the exact point of the score *Average* included scores from 90 to 110, with refinements of 90 to 95, lower average, 95 to 105 as average, and 105 to 110 as slightly above average Because *superior* is so often misinterpreted and because there is the possibility of environmental acceleration giving temporarily an advanced score, the Examiner was slow to so diagnose children One hundred and

forty and above was, however, generally accepted as the superior group. From 110 to 140 was the above-average group, qualified by numerical scores such as DQ 120, 130, etc The *dull normal* group were those rated from 80 to 89, and refined to upper and lower part. *Borderline* was 70 to 79 A DQ below 70 was *apparently feebleminded*, but with a very young child a definite feebleminded condition is not so certainly ascertainable, particularly on a single test. Subnormality is, of course, recognizable early, but physical condition and poor environmental background often hold back the development, and in some of these cases the subnormality was not as marked later as on the first test The writer's tendency is always to be cautious in diagnosing definite feeblemindedness and also superiority. In other words, the extremes are accepted more tentatively

Although for social planning it makes little difference whether a score is 90, 95, or 100, for statistical consideration variations in diagnoses of more than 5 points should be studied. A diagnostic variation within 5 points seems so negligible that two ratings, for instance 91 and 95, have been considered the *same diagnosis* and are so described in this study

In addition to the amount of variation, it matters whether the change represents improvement or deterioration, particularly in the individual case, and therefore positive and negative changes have been reported

Results of Retests

Using the above diagnostic classification, let us examine the findings for stability and for amount of change. One would expect it to be more difficult to estimate ability the lower down in the age scale one goes, and, therefore, to show whether this is so, and to how great a degree, percentages are shown by age groups, that is, age at time of first test Four groups were used, 3 to 11 months, 12 to 23 months, 24 to 35 months, and 36 to 47 months Referring to Table 5, we see that for babies tested first when under one year of age, in 48% of the cases the diagnoses in the final examination did not vary as much as 5 points from the initial test; from 1-2 years, 52%, from 2-3 years, 55%, from 3-4 years, also 55% Therefore, after 2 years and until 4, predictability is 55%, but under 2 the change is slightly greater, while under 1 year, it is 7% greater than from 2 to 4 years. For the whole group from 3 months to 4 years, the predictability was 52.5% This checks very well with Gesell's study of 90 selected cases, for he reports that in 50% of his group the divergence was less than 5 points.

TABLE 5

PERCENTAGES SHOWING STABILITY IN DIAGNOSES BETWEEN FIRST AND LAST TEST IN RELATIONSHIP TO AGE AT FIRST TEST

Age at first test→ / Variation	3-11 mos No	Percentage		12-23 mos No	Percentage		24-35 mos No	Percentage		36-47 mos No	Percentage		All cases No	Percentage	
Diagnosis same	41	47.7		67	51.5		72	54.9		49	55.1		229	52.5	
Plus 5 to 9 pts	16	18.6	77.9	23	17.7	77.7	18	13.7	77.8	17	19.1	87.7	74	17.0	79.8
Minus 5 to 9 pts	10	11.6		11	8.5		12	9.2		12	13.5		45	10.3	
Plus 10 to 19 pts	11	12.8	19.8	18	13.8	19.2	18	13.8	19.9	3	3.3	11.2	50	11.4	17.8
Minus 10 to 19 pts	6	7.0		7	5.4		8	6.1		7	7.9		28	6.4	
Plus 20 or more pts	1	1.2	2.4	2	1.5	3	2	1.5	2.3	1	1.1	1.1	6	1.4	2.3
Minus 20 or more pts	1	1.2		2	1.5		1	.8		0			4	.9	
Total cases	86		20	130		30	131		30	89		20	436		

Gesell also reports with his 90 restudied cases that 84% showed less than 10 points variance, either plus or minus. In the writer's 436 cases, the stability is slightly less, 79.8% for the entire group. As stated above, for fluctuations of less than 5 points there was with each increasing year an increasing percentage of stability, 48%, 52%, 55%, and 55%. When fluctuations of 10 points are studied, age at first test makes less difference—under 1 year, 78%, 1 to 2 years, 78%; 2 to 3 years, 78%. However, between 3 and 4 years, the stability was much greater, 88%. In general, we can say, therefore, that less fluctuation in test findings can be expected at 3 years than below, for at the point, when a fuller range of specific abilities is usually in evidence, it is possible to diagnose with less error.

A fluctuation of from 10 to 20 points appeared in 17.8% of the entire group, or in 19% under 3 years, and in 11% from 3 to 4 years.

Only 10 cases, or 2% of the group, showed a fluctuation of 20 or more points. Here the number of cases is so small as to make the percentage difference by age groups of little significance.

Although of no importance for diagnostic accuracy, but of importance to social planning is the fact that, where the diagnosis did vary on a retest, the divergence was distinctly in favor of improvement rather than deterioration. For the entire group, where the variations were from 5 to 9 points, 17% improved, 10% deteriorated; with variations from 10-19 points, 11% improved, 6% deteriorated, with variations of 20 or more points, 1.4% improved, .9% deteriorated. The total number raising their score 5 or more points was 30%; lowering it, 17%. The total raising their score 10 or more points was 13%; dropping their score, 7%. Thus we see that, where there was a change in diagnosis, the change was almost 2 to 1 in favor of improvement over deterioration. The reasons for this will be discussed later.

Fluctuation in relationship to the *interval between the first and last test* is also considered. Is there more change the farther apart are the tests? The figures show this to be the case, but not to a marked degree nor in a consistent relation to the increasing interval. Stability within a 10-point range when the interval was under 1 year was 87.5%; interval 1 to 2 years, 83%, interval 2 to 3 years, 76%; interval 3 to 4 years, 65%, interval 4 to 5 years, 64.5%. But, when the interval was 5 or more years, the percentage of constancy was 84%, distorting the curve of the other percentages. Fluc-

TABLE 6

PERCENTAGES SHOWING STABILITY IN DIAGNOSES IN RELATION TO TIME BETWEEN FIRST AND LAST TESTS

Time between first and last test→	6 mos to 1 yr			1 to 2 yrs			2 to 3 yrs			3 to 4 yrs.			4 to 5 years			5 plus yrs		
Variation	No	Percentage		No	Percentage		No	Percentage		No	Percentage		No	Percentage		No.	Percentage	
Diagnosis same	71	59		90	56		25	41		23	44		13	42		7	52	
Plus 5 to 9 pts	25	21	87.5	28	18	83	7	12	75	6	11	65	5	16	64.5	3	24	34
Minus 5 to 9 pts	9	7.5		15	9		13	22		5	10		2	6.5		1	8	
Plus 10 to 19 pts	12	10	12.5	13	8	15	10	17	24	12	23	31	2	6.5	22.5	1	8	16
Minus 10 to 19 pts	3	2.5		11	7		4	7		4	8		5	16		1	8	
Plus 20 or more pts				3	2		1	1		1	2		1	3				
Minus 20 or more pts										1	2		3	10				
Total cases	120			160			60			52			31			13		

TABLE 7

Percentages Showing Stability in Relation to Number of Tests

Number of tests	2 No	2 Percentage		3 No	3 Percentage		4 No	4 Percentage		5 No	5 Percentage		6 or more No	6 or more Percentage	
Diagnosis same	149	63		46	37		20	43		10	53		4	45	
Plus 5-9 pts	38	16	87	26	21	74	10	21	73			58			
Minus 5-9 pts.	20	8		20	16		4	9		1	5				
Plus 10-19 pts	18	8	11	15	12	24	7	15	21	7	37	42	3	33	44
Minus 10-19 pts.	8	3		15	12		3	6		1	5		1	11	
Plus 20 or more pts	1	1	2	1	1	2	3	6					1	11	
Minus 20 or more pts	3	1		1	1										
Total number of cases	237			124			47			19			9		

tuations of more than 10 points present a still more uneven curve, but tend to establish the same general fact.

How does the *number of tests* affect the stability of the diagnoses? Table 7 shows that the greater the number of tests, the greater the change between the first and last tests if a variation less than 10 points is being studied, but for a variation of more than 10 points the reverse is true With two tests being given, 87% of the cases varied less than 10 points when retested, with 3 tests, stability was 74%, with 4 tests, 73%, with 5 tests, 58%, with 6 or more tests, 45%. Eleven per cent of the cases given 2 tests varied 10 to 19 points, those given 3 tests, 24%, those given 4 tests, 21%, those given 5 tests, 42%, and those given 6 or more tests, 44%. The small number of cases given 5 or more tests may make these percentages less reliable, but further study would be most valuable

Further Causes of Fluctuation

In addition to the factors discussed above, there are less analyzable causes tending to produce fluctuation. Since the same examiner did all the testing and since the same scale of tests was used throughout, we cannot lay the change to the test, themselves, or the controllable conditions under which they were given. Further causes for fluctuation would seem to be due to less controllable factors such as the physical conditions of the children, emotional attitudes towards the tests, language difficulty, or environmental changes Statistically, it is very difficult to evaluate causes such as these. At times there seems to be a combination of factors which produces the diagnostic variations With many cases, the cause of fluctuation, because it is the most outstanding, seems to be established, but there is no certainty All we can surely say is that such and such are the apparent causes for the fluctuation.

Table 8 gives the probable reasons for fluctuation and the number of cases fluctuating in this series of restudied cases. One outstanding cause of variation in diagnosis was apparently due to the changed environment of the child between the time of the first and the last tests. Most of the dependent group, which are chiefly the basis of this study, were committed for foster-home care because their own homes and parents were inadequate Many times this meant lack of finances with improper diet, lack of suitable housing and play facilities, improper habit training, and unhealthy emotional training My psychological studies were unavoidably made almost immediately

TABLE 8

PROBABLE REASONS FOR FLUCTUATION AND NUMBERS FLUCTUATING

Variation	Environmental change	Physical condition	Emotional instability	Language development	Undetermined	Total Number
+ 5 to 9 points	36	7	6	9	16	74
— 5 to 9			2	32	11	45
+10 to 19	25	5	1	9	10	50
—10 to 19				23	5	28
+20	4	2				6
—20				2	2	4
Total number	65	14	9	75	44	207
	15%	3%	2%	17%	10%	47.5%

on reception of the child into foster-home care. Retests a year or two later indicated that, where there was a change in diagnosis, approximately 50% of the improvements seemed to be because of the better environment in which the child had been placed. All his potentialities were being given a chance for expression.

Improved physical condition seems to correlate in some cases with improved mental status, but not in the proportion which has generally been believed—in this study only 3% of the entire group.

Neither does emotional difficulty, even with very young children, play as much part in distorting the psychological picture as the writer had formerly believed. There was only one case in the entire group of 436 where emotional attitude caused a change of 10 or more points on a retest. This does not mean that every child was amenable and entirely conformed to the test situation. By no means—a great deal of ingenuity was often required to put through the test. But, after experience with preschool children, it is unusual to meet a child whose behavior makes a reliable diagnosis very uncertain. Small children are often quite distractible, tests have to be presented as the child is interested and they may have to be interspersed with free play, but, with the large amount of standardized material available, enough satisfactory responses are usually obtainable to make a correct diagnosis possible.

It is in the verbal field rather than in the non-verbal that difficulty is most often encountered. This is especially true with very shy youngsters. But this obstacle can usually be met by securing a

careful developmental history concerning appearance and amount of language. The greatest handicap to accurate diagnosing of preschool children, and especially of those under four years, is the absence or small amount of language which is developed at the time of the test Until language has appeared it is not possible to evaluate the intellectual level, which is the chief index to superiority or inferiority This means that the bright child cannot always be recognized early. There are some children who are equally advanced in motor development, adaptive reactions, and language But more often with really superior children, and this has been shown with older groups also, manual skill and general behavior are not above average or very little so, and the superiority is all in the verbal abstract field

The absence or slow development of language may also distort the psychological picture of the dull or the definitely feebleminded child In body control and in manipulating manual material, some dull children give a fairly average picture, and, because they are young, their slow language is not so significant This is especially true with children under 30 months But, when retested at an older age, limited verbal ability is much more significant and serious Many of these retarded children continually show good concrete ability on all retests, but deteriorate intellectually as more is demanded of their verbal processes This type of case was the chief one showing deterioration on retests. In fact there were only two other cases in the whole group showing a deterioration of more than 10 points which gave any other reason for not continuing to develop at the expected rate according to the first diagnosis.

Percentages and Causes of Variation as Compared with Foran's Study

Dr Foran has contributed an important summary of the changes in IQ when children are retested by Binet tests, and, because this is the most extensive study of retested older children, the writer wishes to present some comparisons between his figures and those obtained in my own study. Dr Foran's study is a summary of the results of studies by various examiners, all of whom used the Stanford-Binet series of tests. He states that the probable error of a Stanford-Binet intelligence quotient is approximately 5 points under average conditions, and, therefore, deviations are only significant if they exceed 10 points, and about 20% of the deviations exceeded 10 points.

For the writer's preschool group, age range from 3 to 47 months, the figures are almost identical with Foran's, 17.8% deviating 10 to 19 points, 2.3% deviating 20 or more points.

Foran has not attempted to give any figures to show relative causes for the variations, but he presents a number of reasons for deviations. Quoting from his conclusions:

> "The largest deviations are observed in children below 6 years, but with the exception of very young children, the constancy of I.Q. is independent of age. Attitudes and interests, as well as habituation to taking tests, are probably the responsible factors in the variations of young children. Language handicap is responsible for a considerable proportion of the fluctuations. Abnormal physical conditions lower the constancy of the intelligence quotient to some degree, but their influence has probably been over-emphasized. The influence of environment is an open question, but with some indications that the I.Q. is constant in spite of pronounced changes in environment. Individual cases may at times show large fluctuations either on account of causes already mentioned, or for reasons that cannot be identified."

Table 8 shows disagreement at certain points with Foran's conclusions. Although there is a decided trend for the ability of very small children to be less predicable, still my entire preschool group is not more variable than Foran's older group. There is the important difference, however, that Foran is considering only Binet scores and not a diagnosis made on complete range of material, including verbal and non-verbal tests, plus developmental history. The writer has found extreme fluctuation in Binet scores for some 3- and 4-year-olds and never feels justified in placing any reliance on just this one scale. An extreme case, which I quote because the general diagnosis did not show any real variability, is that of a boy whose Binet IQ was, at 2 years 5 months, 179; at 3 years 10 months, 160, at 4 years 10 months, 140, and at 6 years 5 months, 150. In analyzing the respective failures and successes, there was the situation of several tests being succeeded one year and failed the next, such things as the distinction of right and left, where confusion is not rare for very small children. This same situation is not met when a qualitative estimate is made from a wider range of material.

The writer found that attitudes and interests interfered very little in making diagnoses, though, of course, it did interfere in some cases

and with occasional tests for a considerable number of children. It was the "shut-in," "afraid to express himself" type of child who was at times wrongly diagnosed, rather than the obviously non-conforming one who had his own aims and desires to satisfy. With the introverted types, only by retests when the child's personality was more expressive could we know that the earlier picture given was incorrect

There is agreement with Foran's study in regard to the emphasis which has been placed on the physical condition, the importance of which has been overly stressed

Conclusions

1. Carefully standardized preschool tests given by an examiner experienced in handling young children seem to be as reliable as tests standardized for older groups

2. Given two or more tests, 52.5% of the cases with an age range of from 3 to 47 months varied less than 5 points when the initial and final diagnoses were compared

3. Seventy-nine and eight-tenths per cent varied less than 10 points.

4 Seventeen and eight-tenths per cent varied from 10 to 19 points

5. Only 2 3% fluctuated more than 20 points.

6 Where there was a change in the diagnoses, about twice as many improved as deteriorated.

7 Children from 36 to 47 months varied less on retests than did children from 3 to 36 months.

8. It can be stated in general that the greater the interval between the tests, the less the stability, but this is not true in a consistent way.

9. The number of tests does not affect the stability of diagnosis in a consistent way

10 Of the 47 5% of cases fluctuating 5 or more points, 15% seemed to be due to improved environment, 3% to physical causes, 17% to language development, 2% to emotional situations, and 10% to undetermined factors

11. If 15% of this group gave a better type of mental response under better environmental conditions, it would seem very desirable to study a control group who had always lived in the same and in favorable surroundings.

12 It seems that too much emphasis has been placed on the retarding effect of physical conditions

13. Although the results of individual tests may be negated because of emotional attitudes, disinterest, or inattention, a very small number of preschool children should be incorrectly diagnosed if time is taken to present sufficient and carefully standardized material

14 Lack of language development, more than any other one cause, makes for errors in diagnosing young children Bright children are often not recognized until language appears, and dull children showing good motor and manual development are often rated too high in the early examinations.

References

1 Foran, T G. The constancy of the intelligence quotient, a review *Cath. Univ Amer Educ Res Bull*, 1926, 1, No 10

2 ————— A supplementary review of the constancy of the intelligence quotient *Cath Univ Amer Educ Res Bull*, 1929, 4, No 9. Pp 42.

3 Gesell, A The mental growth of the pre-school child New York Macmillan, 1925. Pp. x+447

4 —————. Infancy and human growth New York Macmillan, 1928 Pp xvii+418

5 Hallowell, D K Mental tests for pre-school children *Psychol Clin*, 1928, 16, 235-276

6 Stutsman, R Performance tests for children of preschool age *Genet Psychol Monog*, 1926, 1, 1-67.

7 Terman, L M. The measurement of intelligence Boston Houghton Mifflin, 1916. Pp 362.

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LA STABILITÉ DES ÉVALUATIONS DES TESTS MENTAUX POUR LES ENFANTS D'ÂGE PRÉSCOLAIRE

(Résumé)

On a fait subir une série de tests à 436 enfants d'âge préscolaire Les âges à la première épreuve ont eté de 3 à 47 mois, à la dernière épreuve de 1 à 9 ans L'intervalle moyen entre les tests ont éte de 18 mois et le nombre moyen de tests, 2 Les tests ont été ceux étalonnés par Gesell, Hallowell, Stutsman et Terman On a employé la méthode de comparer les résultats de la première épreuve avec ceux de la dernière pour déterminer la vraie valeur d'une seule étude faite à un âge non avance

Quand on a comparé le diagnostic initial et le final, 52 pour cent ont varié moins de 5 points, 80 pour cent moins de 10 points, 18 pour cent de 10 à 19 points, et seulement 2 pour cent ont varié plus de 20 points. Quand

on a change le diagnostic, le nombre de ceux qui ont fait des progrès a été environ deux fois le nombre de ceux qui ont fait moins de progrès qu'auparavant Les enfants âges de 36 à 47 mois ont varié moins dans les tests répétes que les enfants âgés de 3 à 36 mois

Sur le 48 pour cent de cas variant de 5 points ou plus, 15 pour cent semblent dus à de meilleurs milieux, 3 pour cent aux causes physiques, 2 pour cent aux situations émotives, et 10 pour cent non determines

Bien que l'on puisse nier les résultats des tests individuels à cause des attitudes emotives, d'un manque d'intérêt, ou de l'inattention, il est possible d'arriver à de bons resultats dans le cas de la plupart des enfants d'âge préscolaire, si l'on a soin de présenter assez de matieres et des matières soigneusement étalonnees

HALLOWELL

DIE BESTANDIGKEIT DER AN INTELLIGENZPRÜFUNGEN ERHALTENEN ZAHLEN BEI VOR-SCHULPFLICHTIGEN KINDERN

(Referat)

Es wurden 436 vorschulpflichtige Kinder einer Testserie unterworfen Das Alter der Kinder erstreckte sich bei der ersten Prufung zwischen 3 und 47 Monaten und bei der letzten zwischen 1 und 9 Jahren Der mittlere Abstand zwischen den Prufungen war 18 Monate, und die mittlere Zahl der Prufungen 2 Die gebrauchten Prufungen waren die durch Gesell, Hallowell, Stutsman, und Terman standardisierten Es wurde so verfahren, dass man die Befunde bei der ersten Prufung mit denen der letzten verglich, um zu ermitteln, wie viel Vertrauen einer einzigen, in fruhem Alter gemachten Prufung zu schenken sei

Bei der Vergleichung der ersten und der letzten Diagnosen zeigte es sich, das 52% innerhalb weniger als 5 Punkten variirten, 80% innerhalb weniger als 10 Punkten, 18% innerhalb 10 bis 19 Punkten, und bloss 2% innerhalb mehr als 20 Punkten. Wo eine Aenderung der Diagnose stattfand zeigte sich zwei mal so oft Besserung wie Verschlimmerung Kinder im Alter zwischen 36 und 47 Monaten variirten bei Wiederholung der Prufung weniger als Kinder zwischen 3 und 36 Monaten

Unter den 48% der Falle die eine Variirung von 5 oder mehr Punkten zeigten schienen 15% durch verbesserte Umgebung verursacht zu sein, 3% durch physiologische Ursachen, und 2% durch affektive Gelegenheiten, und bei 10% war die ursache der Verschiedenheit unbestimmt

Obwohl die Befunde bei individuellen Prufungen durch Gemutszustande, Mangel an Interesse oder Unaufmerksamkeit vereitelt werden konnen, soll doch an nur wenigen Kindern eine unrichtige Diagnose gemacht werden wenn man sich genugend Zeit nimmt um hinreichenden und vorsichtig standardisierten Teststoff darzubieten

HALLOWELL

THE DIRECTION OF READING AND THE EFFECT OF FOREIGN-LANGUAGE-SCHOOL ATTENDANCE ON LEARNING TO READ[*]

From the Territorial Normal and Training School, Honolulu, Hawaii

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SCOPE OF THE PRESENT INVESTIGATION

Purpose. In a study on special reading disability by Marion Monroe (5) attention is directed to the much higher number of errors involving the reversal or inversion of letters and sounds among cases of special reading disability than among normal readers. This fact suggested the problem of whether or not the learning to read at the same time two different languages whose order of direction differs leads to greater confusion and a higher number of errors of reversal among normal children than is the case when but one language is studied at a time. This is a problem of direct practical interest in the Hawaiian Islands, as a large number of six-year-old children each year enter two schools the public schools where they are taught to read English, which is written in horizontal direction from left to right, and some foreign-language school where they learn to read Chinese, Japanese, or Korean, all of which are written in the vertical direction from right to left. A subsidiary problem developed in the course of this study, namely, which of these different reading directions is the more natural to the child untutored in reading?

Subjects. The subjects used in this investigation included 740 children from two to nine years and 112 adults, all residents of Honolulu. The younger children were nearly all from either Castle Nursery School and Kindergarten or Kinau Kindergarten, where children of both Oriental and Caucasian ancestry are to be found. The children of school age were found in the practice schools of the Territorial Normal School and in four other public schools of Hon-

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[1]Mrs. Virginia Carey assisted in the planning of the Reading-Direction Test, constructed Form B, and assisted in some of the testing

olulu, and also a small number were found in the Korean Christian Institute, a private foreign-language school. All of these children were either in the first grade or were studied during the first months after promotion to second grade in the public schools The adults were students or faculty members at the Normal School and their friends.

Test for Preferred Reading Direction

In order to discover whether or not preschool children have any preference for a special direction in reading or naming objects, a test was prepared in two forms consisting of 25 simple outline pictures arranged in five rows of five each on a 12-inch square of heavy paper. In order that, as far as possible, the words illustrated should be in the vocabularies of the children tested, the pictures represented words found to be of high frequency in the vocabulary of the children before entering the first grade In Form A the pictures used represented words in the first thousand words according to frequency as listed in the kindergarten or home lists of the International Kindergarten Union study (2) On Form B a few words of a somewhat lower frequency in these lists but probably more widely known in Hawaii were included, e.g., pineapple.

Pictures used in Form A represented.

ball	telephone	dog	house	shoe
chair	baby	penny	boy	clock
chicken	rose	moon	tree	fish
hat	girl	boat	man	table
cup	flag	cow	egg	pencil

Pictures used in Form B represented:

box	cabbage	bread	comb	milk-bottle
umbrella	bunny	Santa Claus	cat	scissors
fly	auto	train	airplane	bird
book	frog	mouse	horse	apple
toothbrush	pig	policeman	pineapple	flatiron

With children the directions used were simply, "Let's see if you can tell me what all these pictures are" No hint was given as to where to begin and the page was laid down on the table exactly in front of the subject so that there would be no suggestion from its position as to where to begin. In the few cases where the subject asked, "Where shall I begin?" he was told, "Just where you wish

It doesn't matter where." If he stopped before completing the task, he was asked if he had finished, but was not otherwise urged unless he had named so few pictures that it was impossible to judge whether or not he had any plan of procedure As the test is to determine *reading direction and not picture recognition,* it made no difference if he miscalled a picture. If he hesitated over any picture at which he was pointing or if it could be ascertained which picture was bothering him, it was named for him With very shy young children, who could not be persuaded to speak, the child was urged to point to each picture and they were named for him, but this was necessary in very few cases With adults, it was usually necessary to explain

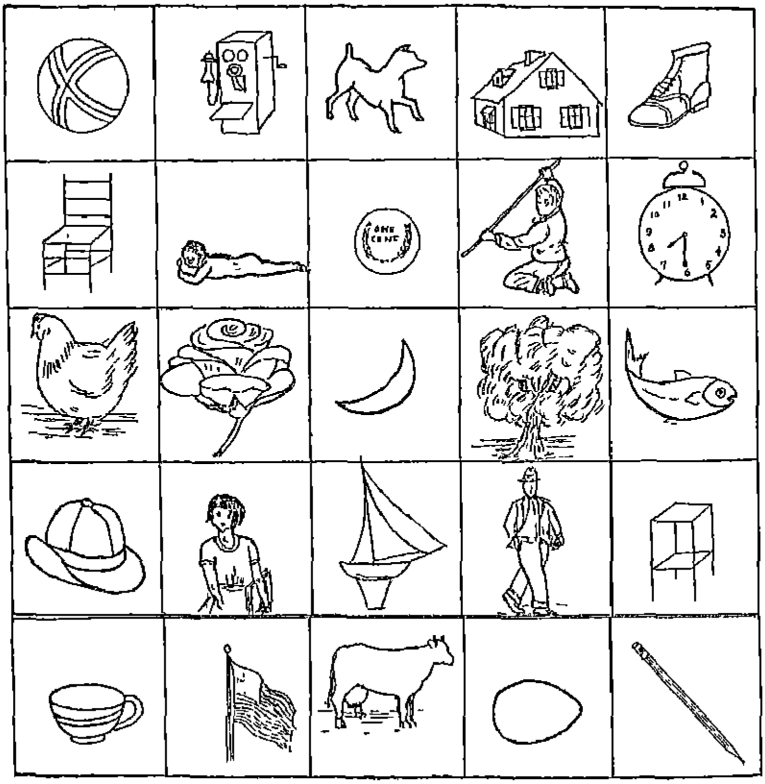

FIGURE 1
READING-DIRECTION TEST—FORM A

that there was no catch and that the purpose of the test would be fully explained as soon as the pictures had been enumerated

Scoring On a sheet ruled into 25 smaller squares a number was entered in each square as the child named the picture in the corresponding square on the large sheet For the first picture named, the number entered was "1," for the second "2," and so on until the child had named all If he named a picture twice the number of each naming was entered in its square A pattern illustrative of the child's plan of procedure could then be traced on the scoring sheet by drawing a line from one number to the following and so on until all had been connected The test was scored in three different ways. The type of pattern followed was noted and named If all five lines were named in order from left to right horizontally, it was called *English*, if horizontally, but from right to left, *Hebrew*, if horizontally, but with direction reversed on alternate lines, *Old Latin*, since ancient Latin inscriptions are found written in such a manner If the child began any of these patterns at the bottom instead of the top of the page, the adjective *inverted* was prefixed to the name of the appropriate pattern Vertical directions were named *Chinese* when begun at the upper right-hand corner, *reversed Chinese* when begun at the upper left-hand corner, *inverted Chinese* when begun at the lower right-hand corner, and *inverted reversed Chinese* when begun at the lower left-hand corner. If the child reversed the order of direction in alternate lines, beginning at the top in some lines and at the bottom in others, the adjective *connected* was prefixed to the appropriate name Another perfect pattern used by some children was called the *spiral* In this pattern, the child follows the edge of the picture card, naming the outside pictures first, and then fills in the remaining pictures Such a procedure results in a sort of spiral If the child neglected to fill in the center or named pictures in two columns at a time so that a rough border effect was produced, the pattern was so-named This, as well as all other patterns observed, was incomplete, that is, some pictures were omitted. Such incomplete patterns were named *Traces of* . whatever pattern was indicated or used part of the time Finally, there was a mere haphazard naming of pictures that followed no other order of procedure than the whim of the child or the degree of attractiveness of the separate pictures to him This was called *haphazard*

Another method of scoring resulted in a numerical score. The rule followed was: From the number of different pictures named subtract

the number of turns in direction up to the 25th picture and add the number of times an adjacent square up to the 25th was named If a regular pattern is followed do not penalize twice by deducting twice for one omission. If the result should be negative, the score is zero The score must be at least as much less than 40 as the number of pictures omitted. A square is counted as adjacent to the one at the opposite end of the line preceding it when the child is following such an order as the English-reading direction, which requires a return sweep of the eye from the end of one line to the opposite end of the line below This rule results in a score of 40 for every regular pattern which results from beginning in one corner of the page and following any of the regular reading directions or these directions reversed or inverted. This was called the *orientation score*

A third score was used to secure a numerical score to describe the degree of tendency to follow the same pattern or lack of pattern on two trials This was called the *difference score* A regular pattern could differ from another in four respects direction might be to the left or to the right, vertical or horizontal, to the bottom or to the top, and the lines could be connected or unconnected. Each such difference counted 1, total 4 A spiral with the same starting point as any other regular pattern gave a difference score of 4, with a different starting point, a score of 5. A complete failure of pattern compared with a perfect one also counted 5. If a partial pattern was found in one case and a perfect pattern in another, the difference score given was the number of lines that differed from 1 to 4. When a pattern was lacking in both records the rule followed was Note if the general direction or scheme is similar or not, if similar, add 0, if different, add 1; if very unlike, add 2, to the difference as measured by difference in orientation score. If the orientation differs in the two cases by 1 to 5 give a difference score of 1, if the difference is 6 to 10, score 2; if 11 to 15, score 3, and so on.

Validity. The adult subjects were used to discover if the test had any real relation to direction of reading Fifty adults who read only English or languages written in a similar direction were tested. Of these, 41 followed the exact English direction, 7 a horizontal direction—Hebrew or Old-Latin or mixtures of these with English—and 2 the reversed Chinese. This latter direction gets some practice in reading columns of figures among English-reading people On the other hand, of 50 adults who read both English and an Oriental language, only 19 named the pictures in the English direction, 10 in

some variety of the Old-Latin direction, 8 in perfect Chinese direction, 11 in reversed Chinese, and 2 in some other variation of the vertical direction. It was found impossible to secure many subjects who could read only an Oriental language For the most part, such subjects could not understand enough English for the writer to test them herself, and, although some of the students of Oriental ancestry at the Normal school offered to help in such testing, they found it very difficult to disarm their friends of the suspicion that this simple test was a means of entrapping them, so that only 10 adults who read Japanese or Chinese only were tested, and 2 illiterates Of these, the illiterates read one in the Hebrew direction and one in inverted Old-Latin direction, 5 of the others followed the Chinese, 1 reversed Chinese, 1 connected Chinese, 1 English, and 2 Hebrew, which has the same starting point as the Chinese direction Thus we find a marked tendency among adult subjects to follow in naming the pictures an order either the same or closely allied to that they most frequently use in reading The Oriental subjects in the Islands have a certain amount of practice in English directions in signs, the comic strip which is printed in the Japanese papers, and in a few of the modern Chinese books which are written in English direction instead of their usual style

In order to test whether any picture by its greater appeal to the child's interest or its difficulty of recognition influenced the direction of naming, the picture chosen as starting point on 486 records from tests with Form A and 314 from tests using Form B, 800 in all, were studied and the number of times each picture was used as the starting point was counted and the relative frequency of each picture on the two forms compared On the perfect records which indicate a reading direction already chosen, 186 on Form A and 154 on Form B began with Picture 1 (numbering of pictures followed the English direction); 34 on Form A, 38 on Form B began with Picture 5, 18 on Form A, 10 on Form B began with Picture 21; and 9 on Form A, 3 on Form B with Picture 25 This looks as if Picture 5 might appeal more on Form B than on Form A, but the difference is more probably due to the fact that fewer children, proportionately, who attended foreign-language schools and had learned to use a Chinese reading direction which begins with Picture 5 were tested with Form A, since Form B, with its somewhat more difficult pictures, was not used so much with the younger children On the imperfect records where order was either lacking or was disturbed,

these corner pictures also showed a rather high frequency except for the pictures in fifth place, the bottle on Form B showing only average frequency and the shoe on Form A less than average frequency But these pictures were always recognized and correctly named by all but the very smallest children, many of whom omitted them altogether. Over-popular pictures were the fish, the 15th on Form A, and the scissors and auto, Numbers 10 and 12 on Form B Less popular, but slightly above the average, were the umbrella and bunny on Form B in Squares 6 and 7. Pictures seldom used for commencing were the rose and moon in Squares 12 and 13 on Form A, and the box, bread, fly, and egg in Squares 1, 3, 11, and 24 on Form B, and all the pictures but the horse in the fourth line on both forms. The fourth line was used less often than the other four as a starting point, and this is a difference due to position, not appeal of picture. The only one of these pictures in such a position as to interfere with a preferred reading direction is the box The difficulty seemed to be due to uncertainty as to whether it should be called a box, a block, or ice Usually, when this happened, before the child could be given the name, he began on the line below, thus not changing his type of pattern but lowering his orientation score by one point However, the children seldom seemed disturbed by failure to recognize the pictures. The penny was generally called a ball without any hesitation, the different mammals were all mistaken for each other, the telephone was frequently called an ice-chest (the picture did not show the dial used on telephones in Honolulu), the cup was called a bowl, particularly by Oriental children who are familiar with a different kind of cup, and the crescent moon was often mis-called, the most frequent error in this case being to call it a banana

Reliability Both forms of the test were given within a few days of each other to 168 children who were attending only one school or kindergarten Of 109 first-graders, 71 followed identical patterns on both trials, and 16 followed patterns that were almost the same. Of 48 second-graders, 41 followed the same, and 6 almost the same pattern Of 11 other children, 8 followed the same, and 2 almost the same pattern. The tendency to repeat the same pattern on different occasions seems to be marked by the time that any idea of order has been established Of the whole group of 168, 146, or 96%, began both times at the top (143 cases) or at the bottom (6 cases); 157, or 94%, began in both cases that were alike in being either connected (31 cases) or unconnected (126 cases), 115 made perfect scores on

both occasions and 35 imperfect scores on both trials, a total of 89% whose scores were alike as to perfection on both trials; 83 used the perfect English pattern on both trials, and 67 some other pattern on each trial, 89% showing like performance in this respect, 17 in both cases used a vertical, 130 a horizontal direction, 7 so confused their patterns that it was impossible to call one or both of them either vertical or horizontal, only 14, or 8%, used both directions; 17 on both trials began at the right, and 116 at the left, or 77% began at the same side of the page each time Evidently, the left-right direction is the least stable part of the pattern and this is precisely the direction in which errors of reversal of letters and sound occur in primary reading On the whole, though, we find considerable agreement among the children in adherence to a pattern form

Results of the Test

Preferred Reading Direction Alice Descoeudres (3), in the course of her tests of language for children of two to seven years, has the child talk about five pages of twelve pictures each She notes that the younger children usually name them in chance order, while the older children usually name them in order, either vertically or horizontally, in most cases following the same order on all five pages We found a similar contrast between our younger and older children The orientation score measures the tendency to follow a regular order, irrespective of the type of pattern used. Only the merest beginning of pattern traces are observable in records scoring below 20, but an increasingly distinct pattern is found with higher scores, quite clear in scores of 30, and reaching perfection with scores of 40. Table 1 shows a steady rise from year to year from an average score of 6 at two years to one of 36 at seven, or of 37 in second-grade seven-year-olds, while the adults with but one exception scored 40. (Children from two years no months to two years eleven months inclusive are counted as two-year-olds) The rise in score is much more rapid the first two years and then a slight gain is found each year thereafter. One reason for the very slight gain at six years is the fact that the children above six years were for the most part drawn from the public schools, which are not so selected a group as the kindergarten groups which supplied the younger children It will be noted that the average score of the Oriental and non-Oriental groups is almost identical until six years is reached, after which the Oriental child who does attend foreign-language school has a markedly lower score.

TABLE I
SUMMARY OF READING-DIRECTION SCORES AND PATTERN TYPES AT DIFFERENT AGE LEVELS

Ages		Race	Number of cases	Average orientation score	Percentage of cases where pattern type was absent	was present in part	was clear	was English	was horizontal	showed horizontal traces	was Chinese	was vertical	showed vertical traces	was spiral	was connected	showed traces of connected types
2 years to 2 years 11 months		Oriental	11	6.4	91	9	0	0	0	0	0	0	0	0	0	9
		Non-Oriental	14	5.6	100	0	0	0	0	0	0	0	0	0	0	0
		All two-year-olds	25	6.0	96	4	0	0	0	0	0	0	0	0	0	4
3 years to 3 years 11 months		Oriental	25	18.8	48	24	28	0	0	4	0	4	8	24	28	40
		Non-Oriental	25	16.9	56	32	12	0	0	12	0	0	0	12	20	40
		All three-year-olds	50	17.9	52	28	20	0	0	8	0	2	4	18	24	40
4 years to 4 years 11 months		Oriental	27	28.0	23	44	33	8	15	19	4	4	15	15	22	56
		Non Oriental	24	28.0	4	65	31	7	12	19	0	4	7	15	15	65
		All four-year-olds	51	28.0	13	55	32	8	14	19	2	4	12	15	19	63
5 years to 5 years 11 months		Oriental	32	31.7	18	21	62	12	35	38	6	15	16	12	29	50
		Non-Oriental	67	31.9	12	19	69	21	34	37	0	9	12	22	37	55
		All five-year-olds	99	31.9	14	20	67	18	35	38	2	11	14	19	34	53
6 years to 6 years 11 months		Oriental in two schools	44	34.0	14	22	64	10	27	30	19	35	39	1	18	36
		Other Oriental	64	34.5	11	10	79	54	61	64	5	18	18	0	7	13
		Non-Oriental	48	34.4	11	23	65	24	53	60	0	9	9	4	39	61
		All six-year olds	156	34.4	12	18	70	33	48	52	7	20	21	2	21	39
7 years and up but still in Grades I and II	Grade I	Oriental in two schools	23	28.8	27	10	63	46	58	65	2	5	5	2	4	7
		One school	14	34.7	15	7	78	59	67	70	4	11	15	0	0	7
		Non Oriental	19	37.3	3	18	72	45	67	71	0	15	15	0	12	21
		All Grade I	56	33.6	15	12	73	49	64	69	2	10	11	1	6	12
	II	Oriental in two schools	48	33.8	10	6	84	35	39	40	12	45	48	2	5	5
		One school	24	37.8	4	0	96	69	73	73	0	22	22	0	4	4
		Non-Oriental	33	39.9	6	0	94	74	83	83	5	9	9	1	6	6
		All Grade II	105	36.7	7	2	91	54	60	61	7	31	32	1	5	5
		All seven years and up	164	35.9	12	8	80	52	61	64	5	24	25	1	5	7
6 years and up	I and II	All Oriental in two schools	115	33.0	14	12	74	29	40	43	13	33	35	1	7	8
		One school	88	36.2	10	6	84	61	67	70	14	17	17	0	5	10
Adults		Read both languages	50	40.0	0	0	100	38	58	58	16	42	42	0	20	20
		Read English only	50	40.0	0	0	100	82	96	96	0	4	4	0	14	14
		Read only Oriental language	10	40.0	0	0	100	10	30	30	50	70	70	0	10	10
		Illiterate	2	47.0	0	0	100	0	100	100	0	0	0	0	50	50

TABLE 2
STARTING POINT IN READING-DIRECTION TEST

Age group	All cases No	All cases Percentage Starting in upper two lines	All cases Percentage Starting in left two columns	Excluding perfect patterns No	Excluding perfect patterns Percentage Starting in upper two lines	Excluding perfect patterns Percentage Starting in left two columns
2 and 3 years	79	15±3 3	30±4 2	79	15±3.3	30±4 2
4 and 5 years	142	54±3 4	51±3 4	100	47±3 4	43±4 1
6 to 8 years	539	89±1 1	72±1 2	169	62±3 1	49±5 3
All perfect patterns	412	90±1 2	81±2 5			
		Differences between age groups				
Between 2- and 3- and 4- and 5-year-olds		39±4 3	21±5 3		32±5 3	13±5 9
Between 4- and 5- and 6- to 8-year-olds		35±3 6	21±3 6		15±5 1	6±6 7

Starting Point. The two- and three-year-old children apparently began with the picture that most interested them, but at the same time there was a marked tendency for them to begin with a picture in the lower half of the page and with one nearer the right-hand margin than the left. The older children shifted the beginning point toward the upper part of the page and the left Thus, at two and three years, 60% of 79 records began somewhere in the two bottom rows, where there is in neither form a picture of above average popularity Twenty-four per cent commenced in the middle row, 11% in the second, and only 4% in the top row Altogether, only 15% of this age group began in the upper two lines (see Table 2), but 54% of the four- and five-year-olds and 89% of the older children did, or, if the perfect records were excluded, the percentages beginning in these two upper lines become 47 at four and five years, with 34% beginning in the two bottom lines, and 62 at six to eight years, at which age only 17% still began in the two bottom rows. As for the perfect records, there were 42 of these at four and five years, of which 30, or 71%, began in the top row; and of the 370 perfect records made by the older children, 342, or 90%, began in the top row

The two- and three-year-old records began in 30% of the cases in the two left-hand columns, in 16% in the middle, and in 53% of the

tests the child began in the two right-hand columns, but the four- and five-year-old children in 51% of their records began in the two left-hand columns, and the older children in 72% of their records began in the two left-hand columns

The differences between each pair of the three groups in respect to beginning at the bottom of the page is significant, being more than eight times the probable error, and, if perfect patterns are included, so is the difference between each of the age groups in tendency to begin at the left, although the differences in these cases are only just four and six times the probable errors This tendency of young children to move from right to left was noted by Baldwin and Wellman (1) in studying the order of placement of pegs in the Wallin peg board. It is also mentioned by Lamb (4, p 216) in her study of the peg board as a test of bimanual dexterity.

It would appear that the direction from right to left of Oriental languages is more natural for young children

Pattern Type Not one of the 25 two-year-olds had any clear pattern in his records, and only one showed traces of a pattern (see Table 1). The percentage of records showing a distinct pattern rises steadily each year, except at six Following the records of only those children of Oriental ancestry who did not attend foreign-language school, this plateau is not found, and 91% of the records at seven years show a clear pattern—not much less than the adult records. At every age, after clear patterns are followed, there is a preference for the horizontal type of direction as contrasted to the vertical except in the case of children attending foreign-language school. This cannot be considered as conclusive evidence of the horizontal type being the more natural as almost all the preschool cases were attending nursery school or kindergartens where they were under the influence of English-reading adults who would probably use such direction when pointing out pictures to the children, and all the school children were receiving some instruction in reading English. In many cases, the child evolves an order of his own which is not used in any reading. Eighteen per cent at three years, 15% at four, and 19% at five follow a spiral pattern with sufficient success for the pattern to be so designated, that is, they follow the edge of the page and then fill in such pictures as are left that they do not forget These children of three to five, who have not yet learned to read, also show a much higher tendency than do the school children to reverse directions on alternate lines as in the

Old-Latin style, thus producing a pattern of connected lines as the spiral also does. The highest percentage of connected-line patterns, 63, is found at four years old and has almost disappeared in the second grade as the child learns the return sweep of the eye in reading.

Repeated Records. A number of children were retested after varying intervals of time. Eight children two and three years old made an average gain on the orientation score of 7.8 in three months, and 17 children of the same age gained, on the average, 9.6 points on a retest after six months. All the other retests were after a six-months' interval. The five-year-olds who were attending kindergarten at both testing periods, 17 cases in all, gained but 0.7 on the average, but 30% of their records were perfect on the first trial. Considering both the older and younger kindergarten groups, 21 cases followed the same type of pattern even after a six-month interval, and in 10 cases the type was similar. Where the type differed, in almost every case it was a higher type of pattern on the second trial.

Thirty-nine school children were retested. Of the 25 attending but one school, the average gain was 4.2 points, although 40% had perfect records at the first trial. Those attending foreign-language school as well as English school gained but 1.6 points. Seven children entered school after their first test. The four who started in but one school gained 7.8 points; the three who started in two schools lost, on the average, 1.0 points. It would look as if further cases would show that instruction in reading is accompanied by increasing perfection in this test only when but one language is studied at a time.

Correlations with Intelligence and with a Trait of Orderliness. Fifty children of three and four years were given the Goodenough test for measuring intelligence by drawings. These children showed a range on the Goodenough test of from 0 to 15, and on the orientation score one of from 1 to 39. They were also rated by two raters, their own teacher and the superintendent of the kindergarten, as to orderliness on a five-point scale: very flighty and disorderly, somewhat flighty and disorderly, average, orderly and systematic, very orderly and systematic. The partial multiple correlation between the orientation score and both sets of ratings with intelligence and chronological age out gave a value of .394. Orientation score and score on the Goodenough scale, with ratings and age partialled out, gave a correlation of $.419 \pm .079$. Chronological age and orienta-

tion score, with ratings and intelligence partialled out, showed a correlation of .356±.085. Evidently the orientation score at this age is to some degree a product of the three factors, age, intelligence, and the trait of orderliness.

A group of 68 children at Kinau Kindergarten were rated by the director in the same manner as the younger children were. These children were almost all five years old with a few a few months older or younger. The average orientation scores for each step of the scale were 31.5 for the 2 rated as very flighty, 28.6 for the 15 rather flighty, 32.1 for the 34 average, 36.1 for those rated rather orderly, and 27.3 for the 3 very orderly children. Combining the scores of the children in the first two steps of the scale, their average score is 28.9 and for the last two steps 34.5, but, on account of the wide range of scores, this difference is not significant. However, a difference in the same direction was found in a similar rating of the first-grade Oriental children at the Normal Training School in the spring of 1930, where the 6 less stable children averaged 32.7 in the fall and 36.0 in the spring, as against their more orderly classmates who averaged 36.2 in the fall and 39.9 in the spring. These differences also correspond with the correlation of .394 for the three- and four-year-old children and are less than would be found were not so many children already making perfect scores on the test. It appears, therefore, that with the less mature children the orientation score is to some degree determined by the trait of orderliness.

One hundred and seventy-six school children in the first and lower second grades who made perfect orientation scores averaged 23.0 on the Pintner-Cunningham Primary Mental Test, while the 68 not making perfect scores averaged 16.6. These children all had two trials on the test and those 127 cases who had difference scores of 0 averaged 24.6 on the Pintner-Cunningham test, as compared with 17.2 for those with difference scores of 1 or higher. The differences of the average scores with the P.E.'s of the differences for each of three groups of these children are given in Table 3. For each group the difference is significant, the difference ranging from three times its probable error in the case of the children attending foreign-language school to seven times its probable error in the case of the difference scores of other Oriental children. Those children making perfect scores on the Reading-Direction Test have a higher intelligence score than those who do not. The orientation and difference scores are then to some extent a measure of intelligence. The average

TABLE 3

COMPARISON OF PINTNER-CUNNINGHAM MENTAL TEST SCORES WITH SCORES ON READING-DIRECTION TEST

	Orientation scores			Difference scores		
	Perfect	Less than 40	Difference	Zero	More than zero	Difference
Non-Oriental children						
Number of cases	53	24		37	40	
Av. score on Pintner-Cunningham	21.3	14.9	6.4	22.7	16.3	6.4
P.E. of mean	0.89	1.22		1.06	0.95	
P.E. of diff			1.51			1.42
Orientals attending foreign-language school						
Number of cases	61	23		48	36	
Av. score on Pintner-Cunningham	25.5	20.2	5.3	26.3	21.6	4.7
P.E. of mean	0.89	1.32		0.98	1.20	
P.E. of diff			1.59			1.55
Orientals not attending foreign-language school						
Number of cases	62	21		42	41	
Av. score on Pintner-Cunningham	21.8	14.7	7.1	24.4	15.5	8.9
P.E. of mean	0.85	0.91		1.01	0.75	
P.E. of diff			1.25			1.26
All children						
Number of cases	176	68		127	117	
Av. score on Pintner-Cunningham	23.0	16.6	7.6	24.6	17.2	7.4

Read down: 53 non-Oriental children who made perfect scores on the Reading-Direction Test averaged 21.3 with a P.E. of .89 on the Pintner-Cunningham Primary Mental Test; 61 Orientals who made perfect scores on the Reading-Direction Test averaged 25.5, the 62 Orientals not attending foreign-language school averaged 21.8, altogether these 176 children averaged 23.0 on the Pintner-Cunningham Test.

score on the Pintner-Cunningham test of those making perfect scores on the Reading-Direction Test is given in the table of norms as equivalent to six years mental age.

Reading-Direction Test and Ability in Reading. There were 206 children in the first and second grades who were given both forms of the Reading-Direction Test and also one or more types of the Gates Primary Reading Test after from six to ten months in the regular school grades. Those 162 children who made perfect orientation scores averaged 8.7±.52 on Type I of the Gates Reading Test, but the 44 who scored below 40 averaged only 3.5±.45. The 124 children whose performances on the two forms of the Reading-Direction Test were identical, thus giving difference scores of zero, averaged 9.6±.60 on the Gates test as against 4.6±.40 for those who varied even the slightest in their two trials. Those 92 children using the English direction averaged 9.2±.67 in their reading test, while the others averaged but 6.3±.27. Every one of these differences are significant, being at least four times its probable error. As shown in Table 4, when the non-Oriental children and the two groups of Oriental children are considered separately, we find that similar comparisons show differences in the same direction which in six out of the nine comparisons are significant. Differences in the same directions are also found for the 93 children who were given all three types of the Gates Primary Reading Test. The difference is significant in the case of the children making perfect orientation scores as compared with those who did not, and is also significant in the other two comparisons if 24 children attending foreign-language school are not included. Detailed comparisons are given in Table 4. There were not enough cases to study separately other directions than that of English reading, but in one school where the children were all tested the same day the 10 using reversed Chinese direction (which is the same we use in reading single columns of figures) averaged 19.4 on the Gates Test, Type I, and the 14 using English direction averaged 20.0. The use of the English reading direction in naming pictures appears to be associated with ability to read English.

Comparisons of Children Who Attend Foreign-Language School with Those Who Do Not

All the children used in this part of the study were of school age, the majority being in the first grade and ranging in age from 5 years

TABLE 4
Reading Ability and Reading-Direction Test

When	Average scores on the Gates Primary Reading Test, Type I, made by															Scores on all three types made by					
				Oriental Children Attending																
	Non Oriental children			English school only			Foreign-language school			Language school part time only		All children studied			All children tested			All children except foreign-language school attendants		
	Number of cases	Average reading score	$P.E.$ of mean or of difference	Number of cases	Average reading score	$P.E.$ of mean or of difference	Number of cases	Average reading score	$P.E.$ of mean or of difference	Number of cases	Average reading score	Number of cases	Average reading score	$P.E.$ of mean or of difference	No of cases	Average reading score	$P.E.$ of means or of difference	No of cases	Gates score	$P.E.$ of means or of difference
Orientation score is perfect	42	5.7	0.68	61	7.5	0.67	55	11.3	0.94	4	23.2	162	8.7	0.52	76	20.8	1.46			
Is less than 40	9	2.2	0.76	15	3.2	0.55	20	4.2	0.81	0		44	3.5	0.45	17	8.9	1.46			
Difference		3.5	1.02		4.3	0.87		7.1	1.20				5.2	0.69		11.9	2.06			
Difference score is zero	34	5.9	0.77	41	9.2	0.89	46	12.2	1.08	3	28.7	124	9.6	0.60	61	20.9	1.68	48	21.1	2.08
Is more than zero	17	3.6	0.82	35	3.7	0.48	29	6.1	0.80	1	7.0	82	4.6	0.40	32	14.3	1.60	21	12.3	1.77
Difference		2.3	1.12		5.5	1.01		6.1	1.30		21.7		5.0	0.72		6.6	2.32		8.8	2.74
Direction used is English	31	6.2	0.83	34	9.2	0.98	24	10.4	1.48	3	28.7	92	9.2	0.67	56	21.6	1.72	45	22.7	2.04
Is any other type than English	20	3.4	0.71	42	4.6	0.57	51	9.0	0.88	1	7.0	114	6.3	0.27	37	14.8	1.73	24	10.4	1.56
Difference		2.8	1.09		4.5	1.13		1.4	1.70				2.9	0.72		6.8	2.43		12.3	2.57

	Non Oriental children	Oriental children attending: English school only	Foreign-language school	Language school part time only
Pintner-Cunningham Mental test average	21.3	20.0	24.3	31

Read There were 42 non-Oriental children whose orientation score was perfect they averaged 5.7 on the Reading Test with a $P.E.$ of .68 of the Oriental children, 61 attended English school only and these averaged 7.5 ± .67 on the Reading Test, but the 55 attending foreign-language school as well as English, averaged 11.3 ± .94, the four who attended foreign-language school only part of the year during which they attended English school averaged 23.2 the average for all 162 children on the Reading Test was 8.7 ± .52 The average score made by the 76 children who made perfect orientation scores and who tried all three types of Gates Primary Reading Test was for all three forms 20.8 ± 1.46 The second line gives the scores on Reading of those whose orientation scores were not perfect or less than forty and the third row gives difference in the averages of the children scoring perfect and less

4 months to 8 years 10 months; the remainder were in the second grade and were studied very soon after school reopened in the fall At Kalihi-Uka and the Korean Christian Institute, the only data available were the scores on the Reading-Direction Test; at the Training School at Waimanalo a few cases were obtained for whom Pintner-Cunningham intelligence scores and scores on the Gates Primary Reading Test, Type I, were available At Kawananakoa, 78 Oriental children were used who were given the Pintner-Cunningham Primary Mental Test, the Gates Primary Reading Test, Type I, and the Smith-Carey Reading-Direction Test, after six months at school At Lanikila School, 36 other Oriental children were given the same sets of tests and also the Gates Primary Reading Test, Type II, after ten months at school At Kaahumanu and Robello Schools, 76 Oriental children were tested with the two types of the Gates Reading and the Pintner-Cunningham only These data were secured for a group of 35 children at the Normal Training School, and, in addition, for all of these, scores on Types II and III of the Gates Primary Reading Test were secured, and for a group of 22 children in the first grade in 1930 scores were obtained on Gray's Oral Reading Test, the Iota Test, and certain other tests used by Monroe in the study of special reading disability

Comparison of Foreign-Language-School Children with other Orientals in Reading When Paired as to Intelligence It was necessary to pair the children on intelligence in order to get any idea of the influence of foreign-language-school attendance on reading Correlations of scores on the Pintner-Cunningham Primary Mental Test and the Gates Primary Reading Test had all proven positive, being as follows. for 51 non-Oriental children .588±.061; for 79 Orientals attending foreign-language school, 788±.029, and for 58 other Orientals, .723±.042 Accordingly, in each school as many pairs were made in the same class as possible Each child that attended foreign-language school was paired with another Oriental child in the same school tested after the same length of attendance at school and with a score differing not more than two points on the Pintner-Cunningham Group Intelligence Test. These pairs were so selected that the average raw intelligence score of the pairs in each school did not differ by more than a single point.

In locating pairs it was found in most schools that the average intelligence rating of the Orientals attending foreign-language school was higher than that of those who were not This may be explained

TABLE 5

COMPARISON OF READING ABILITY OF FOREIGN-LANGUAGE-SCHOOL ATTENDANTS AND NON-ATTENDANTS WHEN PAIRED ON THE BASIS OF MENTAL TEST SCORES

School	Number of pairs	Non-attendants Average scores in				Attendants Average scores in				Difference in scores in reading
		Pintner-Cunningham Mental Test	Gates Primary Reading Test Types I	I and II	All	Pintner-Cunningham Mental Test	Gates Primary Reading Test Types I	I and II	All	
Lanikila	11	27 6		26 5		27 7		23 0		3 5
Robello	11	27.1		37 0		27 3		22 9		14 1
Kaahumanu	25	35 4		56 6		35 9		51 4		5 2
Normal Training	11	21 5			18 5	21.7			9 7	8 8
Miscellaneous	15	22 0	9 1			21 0	5 9			3 2
Kawananakoa	27	20 5	4 6			20 5	3 1			1 5
All cases given all three types of tests	11	21 5			18 5	21 7			9 7	8 8
Given Types I and II only	58	29 7		39 93		29 7		32 69		7 24±2 76
PE of means				1 93				1 98		
Given Type I only	100	26 0		16 57		26 0		13 27		3 30±1 29
PE of means				96				86		

by the fact that, since the foreign-language schools are private schools charging tuition, aside from those children whose parents have lost interest in the culture of the land of their ancestors, those children who do not attend are from homes of lower economic status or those whose parents are not much concerned with their children's education, both of which conditions would be more likely to be found among the less intelligent One hundred and seven pairs were found in seven schools. Seven pairs are not included in the comparisons of reading scores as they had been in school but two months. Since the second-grade children made so nearly perfect scores on the Reading-Direction Test, it was not given in that grade to those tested after the first months of school

Reading Direction. The differences for all one hundred pairs (see Table 5) in the Gates Primary Reading Test, Type I, was 3.30 ± 1.29, while on the Pintner-Cunningham the difference was 0 0 In the case of 58 pairs who tried both Types I and II of Gates, the difference of the averages was 7.24 ± 2.76 and four pairs differed 3.4 on Iota Word Test and 1 5 on Gray's Oral Reading Test In only 23 of the hundred pairs did the difference in reading score favor the foreign-language-school attendant, and in each of the six groups the average score always favored the non-language-school children. The difference in this direction is much more frequent than would occur by chance.

Sixty-four of the pairs were given the Reading-Direction Test. Although the average orientation scores were almost the same, this was because of a few very low scores among the non-language-school children, for there were four more cases with perfect orientation scores The average difference score for the non-language-school children was 0.88, or 0 43 less than that of the foreign-language-school attendants. Comparisons of these 64 pairs of children on the Reading-Direction Test are found in Table 6. The greatest difference is in type of pattern used, where the difference is very nearly three times its probable error.[2] Further comparisons on the Reading-Direction Test are given in Table 1 where orientation scores and

[2]The formulas used were $P.E._p = \sqrt{.6745 \frac{PQ}{N}}$ where P=proportion, $P+Q=1$, N=population, and $P.E._{diff} = \sqrt{P.E._1^2 + P.E._2^2}$ where $P.E._1$= $P.E.$ of one percentage and $P.E._2$ that of the other percentage

pattern types are shown for every child tested and averages are given separately for the two groups. It will be noted that even when there is no pairing on intelligence that the orientation scores of the foreign-language-school attendants is lower than that of other children of oriental ancestry and that the former show a markedly higher percentage of Chinese and vertical types of patterns and a

TABLE 6

COMPARISONS OF CHILDREN ATTENDING FOREIGN-LANGUAGE SCHOOL WITH THOSE WHO DO NOT ATTEND WHEN PAIRED ON THE BASIS OF SCORES ON THE PINTNER-CUNNINGHAM PRIMARY MENTAL TEST AS TO PERFORMANCE ON READING-DIRECTION TEST

	Foreign-language-school attendants		Non-attendants of foreign-language school		Difference	
Number of cases		64		64		
Average orientation score		34.9		35.0		
Percentage of perfect orientation scores		70±4.7		78±4.2		8±6.3
Average difference scores		1.31±.23		.88±.15		.43±.27
Percentage of zero difference scores		56±5.1		50±5.1		66±7.2
	Number	Percentage	Number	Percentage	Number	Percentage
Using English pattern type	18	28±4.6	31	48±5.1	13	20±6.9
Other horizontal types	9	14±3.6	8	12±3.3	1	2±4.9
Using reversed Chinese type	4	6±2.4	4	6±2.4	0	0
Other vertical types	16	25±4.4	6	10±3.1	10	15±5.4
Both vertical and horizontal in one pattern	7	11±3.2	4	6±2.4	3	5±4.0
Traces of pattern only	10	16±3.8	11	17±3.4	1	2±3.1

lower percentage of English and horizontal types. The average orientation score of the foreign-language-school attendants is 0 5 less than that for the other Oriental children at six years, when many of the cases had been in school for just a couple of months. Considering only those seven-year-olds who had been promoted to the second grade, the difference in favor of those attending but one school is 4 0. Only 64% of the foreign-language-school children had clear patterns at six years, and 63% of the first-graders and 84% of the second-graders at seven years, as compared with 79% at six, 78% for first grade, and 96% for the second grade at seven years for the other Orientals The foreign-language-school attendants show higher proportions of vertical and connected patterns and a much lower proportion of English and horizontal patterns, especially at six years. The gain in orientation score on retests by the foreign-language-school attendants, as noted above, was 1 6, as compared with 4 2 for the others

Tendency to Repeat Same Direction. (See Table 7) The percentage of children in the foreign-language group who began both times at the top or both at the bottom, who moved vertically both times or horizontally both times, whose score agreed in perfection both times, and who used connected or unconnected lines on both trials was in every case less than the percentage for children who did not attend foreign-language school In the other tendency, that of left or right, the two groups agreed almost exactly In no case, however, is the difference truly significant, but it seems to indicate a tendency for the foreign-language-school children to be less certain of direction to be used

An Intensive Study of One First-Grade Group. All Oriental children in the first grade at the Normal Training School in the spring of 1930 were given Gray's Oral Reading Test, the Iota Word Test, and Monroe's tests for discrimination of *b, d, p, q, u,* and *n* and for recognition of letters written in mirror direction This group included 22 children, 6 of whom did not attend foreign-language school, 12 of whom had attended foreign-language school as long as they had English school, and 4 of whom had attended foreign-language school about half as long as they had the English school. In the foreign-language group, there was one child who had attended school one-half of the previous year and one who had not entered school until the second semester The same was true in the non-foreign-language group The 4 who had been irregular atten-

dants at foreign-language school had a higher mental rating, an average of 27.2 in the fall, than the average of either of the two groups. The 4 of the non-foreign-language school group who had been in school for almost one full year averaged 19.0 in the spring on the Pintner-Cunningham Intelligence Test and the 10 foreign-language-school children who had been in school the same length of time averaged 19.2. In the fall, the respective averages of these two groups were 14.8 and 15.6. So these two groups are comparable, but the children of the non-foreign-language-school group who had been in school one-half and one and one-half years were of con-

TABLE 7

TENDENCY TO REPEAT SAME DIRECTION ON BOTH FORMS OF THE READING-DIRECTION TEST

Both times	Percentage using the same method on both trials of 168 non-attendants of foreign-language school	89 attendants of foreign language school	Difference
Began at top or bottom	96.42±1.24	92.13±2.36	+4.3
Used connected or unconnected patterns	93.45±1.50	89.89±2.61	+4.6
Made perfect or non-perfect scores	89.28±1.98	87.64±2.73	+1.6
Used English or non-English patterns	89.28±1.98	91.01±2.49	—1.3
Moved vertically or horizontally	91.30±1.85	86.59±2.93	+4.7
Began at left or right hand	79.16±2.58	79.78±3.61	—0.6

Read: Of 168 children who did not go to foreign language school, 96.42% followed the same method on both trials of the test as to beginning at the top or bottom of the page, beginning both times at the top or both times at the bottom; of 89 children who attended foreign-language school, 92.13% began both times in the same place, either both times at the top or both times at the bottom. The latter percentage is 4.3 less than the former, viz., the foreign-language-school children show a percentage of 4.3 less than the others in respect to similarity of starting both times in the same half of the page, top or bottom.

TABLE 8

AVERAGE SCORES FOR COMPARABLE GROUPS STUDIED INTENSIVELY

	Ten foreign-language-school attendants		Four non-foreign-language-school attendants		Four irregular attendants	
	Fall	Spring	Fall	Spring	Fall	Spring
Pintner-Cunningham scores	15 6	19 2	14 8	19 0	25 2	31 8
Goodenough intelligence scores	15 4		14 2		12.5	
Orientation scores	36 4	37 6	31.0	40 0	36 5	40 0
Difference scores	1.6	0 8	1 5	0 5	1 5	0 2
Percentage of English patterns used	10	70	38	62 5	25	87 5
Gates reading scores						
on Type I		4 8		10.2		23 2
on Type II		3 8		6 0		18 0
on Type III		7.7		9 8		15 2
Total score on Gates Test		16 3		26 0		56 4
Gray oral reading score		0 5		2 0		4 5
Iota Series Iota Word Test		4 8		11 2		13 5
Errors in discrimination of letters		9 2		1 0		2 2
Errors of reversal		15 9		7 5		11 3

siderable higher intelligence in both cases. As shown in Table 8, the regular foreign-language-school group makes a poorer showing in gain from fall to spring on the Reading-Direction Test and much the lowest scores on all three reading tests tried

Analysis of errors according to the method described by Monroe shows that not only on the special test for discrimination of *p*'s and *q*'s and other letters which differ only in orientation do the regular foreign-language-school attendants show much more confusion, but they also show many more errors of reversal in the rest of the test, the averages being 7.5 for the non-foreign-language-school group, 11.8 for the irregular attendants, and 15.9 for the foreign-language-school group, or, considering the percentage of such errors to other errors in reading, 8.3, 14.6, and 14.9, respectively. Three of the foreign-language group had entered foreign-language school sometime the year before starting English school, and these children scored 1.0 on Gray, 9.0 on Iota, 20.7 on Gates, 8.7 errors in recognition of *p*'s and *q*'s, and 6.0 on recognition of mirror orientation, but they made 19.0 errors of reversal, or 18.3% of all their errors. The entire test for recognition of the orientation of letters and words was not given but only the first half, or that dealing with recognition of letters only. In this test the two groups are almost equal if the means are compared but not if the medians are compared, as the high average of the non-foreign-language school group is due to one child's score of 16.

It appears that the relatively poorer showing of the foreign-language-school children is due in part to a greater confusion of orientation of letters and words on account of their learning two reading directions at once. The somewhat better showing of those who started in foreign-language school earlier, and the markedly better showing of the four who began foreign-language school later or else attended but a short time, may be due solely to their higher mentality according to the Pintner-Cunningham (the three averaged 21 in the fall) or it may be that, if the child has a start at one language, the different reading direction of the second is not so confusing as when both languages are begun together.

In Table 9 are given further comparisons drawn from this intensive study. Whether all children are considered, or only the eight paired individually on intelligence rating, the foreign-language-school attendants score lower on all three reading tests and make the most or practically the same number of errors except for errors involving the whole word, such as substituting one word for another, or omitting, adding, or refusing to try words. The greatest differences are in errors of vowel sounds or reversals which are those errors most clearly differentiating normal and retarded readers ac-

TABLE 9

ANALYSIS OF READING ERRORS OF ALL CASES STUDIED INTENSIVELY

	Number of cases	Average Pintner Cunningham score	Reading Direction Test: Orientation score	Difference score	Zero scores (%)	English patterns (%)	Reading test scores on: Gates Primary all types	Gray Oral Reading	Iota Word Test	Distribution of reading errors: Errors in discrimination of b, d, p, and q	Vowels	Consonants	Reversals	Sounds added	Sounds omitted	Sounds substituted	Word errors	Total	Percentage of reversals of all errors
Non-foreign-language school	6	23.5	40	0.3	67	75	27.8	1.5	11.3	*1.6	18.3	16.7	9.8	3.1	8.0	4.0	29.5	89.3	11.0
Regular attendants	12	19.2	37.8	0.8	67	62	14.0	0.4	5.2	*9.8	26.9	20.8	16.6	4.0	11.6	5.9	34.2	110.0	15.1
Difference		+4.3	+2.2	−0.5	0	+13	+13.8	+1.1	+6.1	−8.2	−8.7	−4.1	−6.8	−0.9	−3.6	−1.9	+5.3	−20.7	−4.1
Irregular attendants	4	31.8	40	0.2	75	88	56.5	4.5	13.5	2.8	22.5	13.5	11.8	6.5	10.5	4.2	11.2	80.2	14.6
Paired by intelligence																			
Non-foreign language school	4	19.0	40	0.5	50	62	26.0	2.0	11.2	*1.0	17.3	14.8	7.5	2.2	7.0	2.8	37.2	88.8	8.3
Regular attendants	4	19.8	40	0.5	75	88	17.2	0.5	7.5	9.7	22.3	14.5	14.2	2.2	9.2	2.0	29.0	93.5	15.3
Difference		−0.8	0	0	−25	−26	+8.8	+1.5	+3.7	−8.7	−5.0	+0.3	−6.7	0	−2.2	+0.8	+8.2	−4.7	−7.0
Using English pattern only	14	24.1	40	0	100	100	29.6	1.6	9.9	*5.1	21.9	15.8	12.0	3.9	9.9	3.8	34.4	91.6	13.1
Using English and reversed Chinese	2	22.0	40	1.0	0	50	27.5	1.5	7.0	4.5	23.0	21.0	13.5	5.0	12.2	7.0	30.0	102.0	13.0
Using all other types	6	19.7	35.7	1.7	17	17	15.3	1.0	5.9	9.5	28.3	23.5	18.3	4.7	11.0	7.5	21.7	115.0	15.9
Making perfect orientation scores	19	23.6	40	0.2	79	82	28.4	1.7	9.4	*5.2	22.2	16.4	12.8	2.8	9.8	3.8	24.3	93.0	13.8
Not making perfect scores	3	16.7	31.3	2.7	0	17	21.1	0	1.7	7.3	33.3	31.0	21.0	7.0	14.0	13.3	17.0	136.7	15.4
Difference		+6.9	+8.7	−2.5	+79	+65	+7.3	+1.7	+7.4	−2.1	−11.1	−14.6	−8.2	−4.2	−4.2	−9.5	+7.3	−43.7	−1.6
Making zero difference scores	15	24.1	40	0	100	93	29.2	1.6	9.6	*6.2	22.5	16.5	12.3	4.0	10.0	3.7	23.7	92.6	13.2
Making higher difference scores	7	18.3	36.3	1.7	0	29	17.6	1.1	5.9	8.1	25.0	22.4	17.4	4.7	11.4	8.1	22.0	112.3	15.5
Difference		+5.8	+3.7	−1.7	+100	+64	+11.6	+0.5	+3.7	−1.9	−2.5	−5.9	−5.2	−0.7	−1.4	−4.4	+1.7	−19.7	−2.3

* One child in each group did not know any letters sufficiently to test

cording to Monroe's study. In errors in reversals, consonant and vowel sounds, they would fall in the class experiencing severe difficulty in learning to read. The non-foreign-language-school children, although in the classification of those experiencing difficulty, in only one of these six comparisons fall in the severe difficulty classification and then just reach its lower limit.

Comparing all the children making perfect orientation and zero difference scores with the rest, we find that they average higher on all reading tests and lower on the differentiating errors, which would suggest a connection between stabilization of reading direction and ability to discriminate letters and their sounds when seen in words. In studying scores made by children using different types of patterns, we find those using the English type only or using it in connection with reversed Chinese make nearly the same scores (the difference being no more than would be expected from their difference in intelligence scores), but much better than the six who, at the end of the school year, were still using other patterns.

Summary and Conclusions

1 A test has been devised that gives an indication of the preferred reading direction of an individual and is useful for showing the progress made by small children toward an idea of systematic procedure in naming a number of pictures distributed over a page

2. This test gives a numerical score that shows an increase with age from 6 at two years to 37 for seven-year-old second-graders and a perfect score of 40 for adults

3. The test shows reliability in the marked tendency of individuals to repeat the same or a similar performance in two different trials and a connection with the known preferred reading direction in the tendency of adults to follow an order of naming similar to the direction in which the language they are accustomed to read is written

4 The youngest children respond to the test by beginning with the picture nearest at hand or that which most attracts their attention Starting below the middle of the page 60% of the time and at the right over half the time, they then follow a haphazard order as they pass from one picture that attracts them to the next Children of four and five years begin about half the time at the left and top and half the time towards the bottom and right They show traces of a systematic type of procedure and some few make perfect records A

frequent type of procedure with them is a spiral, that is, a plan that takes them first around the edge of the sheet and then fills in the center if it is not forgotten. Another plan found more frequently with them than with older children is the Old-Latin or a similar plan in which the order of direction reverses on alternate lines or columns, resulting in connected patterns. Six- and seven-year-old children approach the standard reading direction of the language they are beginning to learn to read, and, by the second grade, practically all children, except those who are learning at the same time to read two languages written in different directions, make a perfect score on the test, repeat the same type of performance on two trials and are using the type of pattern corresponding to the direction of reading in the language they are learning.

5. The test shows a low correlation with chronological age, with mental age as measured by the Goodenough test of drawing a man, and with the ratings on the trait of orderliness with three- and four-year-old children The partial multiple correlation between the orientation score and both sets of ratings with both intelligence and chronological age held constant is .394 Orientation score and chronological age with ratings and intelligence held constant show a correlation of 356± 085, and the correlation between orientation score and score on the Goodenough scale with ratings and age partialled out is .419%± 079. Differences in average scores on the test for older children rated as orderly and those rated as flighty also indicate a slight influence of this factor in score on the test.

6. First- and second-grade school children making perfect orientation scores and those repeating the same pattern averaged significantly higher on the Pintner-Cunningham Primary Mental Test than did the others, the average Pintner-Cunningham scores being 23 0 for those with perfect orientation scores, 16 6 for those whose scores were not perfect, 24.6 for those with zero difference scores, and 16 6 for those with larger difference scores.

7 The Reading-Direction Test shows significant correlation with ability in reading as measured by different reading tests· The difference in average scores on Type I of Gates Primary Reading Test between those making and those not making perfect orientation scores being 5.2±.69, and for those making and those not making zero difference scores being 5.0±.72; and for those using an English type of pattern and those using other types being 2 9±.72 For those children who were given all three types of Gates Reading

Test these differences were respectively 11.9±2.06, 6 6±2 32, and 6.8±2 43, or, omitting foreign-language school, the last two differences were 8 8±2 74 and 12 3±2 57. The few children intensively studied also showed similar differences in scores on Gray's Oral Reading and the Iota Word Tests and a higher number of errors of reversal in reading among those who made orientation scores of less than 40, or who made more than zero in difference scores, and those who used pattern types other than English.

8. Children attending foreign-language school make lower scores on the test, show greater variability in type of performance, and use the English type of pattern less frequently than do those attending English school only; the last difference, however, is the only one that is significant, 2 0±6 9.

9. When paired on intelligence scores and tested after varying periods of instruction, the foreign-language-school children in each school so tested scored lower on reading tests than did the other Oriental children The difference on the Gates Test, Type I, was 3.30±1 29; for those tested on Types I and II of the Gates Test it was 7 24±2.76 The few intensively studied also averaged lower on Gray's Oral Reading Test and the Iota Word Test

10. Intensive study of the errors made by Oriental children in reading seems to point towards a definite confusion of orientation among those children that attend two schools, which is probably a factor in their delayed progress in reading

11 Children may not be quite so disturbed by the different reading direction if they do not enter both schools at the same time

12 It would be well for teachers of Oriental children attending foreign-language school to pay particular attention to teaching the children the approved English reading direction, specifically calling their attention to the difference, and to pay much attention to the teaching of words and letters easily confused in orientation

References

1. Baldwin, B T, & Wellman, B L The peg board as a means of analyzing form perception and motor control in young children *J Genet Psychol*, 1928, 35, 387-414
2. Child Study Committee of the International Kindergarten Union A study of the vocabulary of children before entering the first grade Baltimore, 1928 Pp 36
3. Descoeudres, A Le développement de l'enfant de deux à sept ans Paris Delachaux & Niestle, 1922 Pp 325

4 LAMB, E O. Racial differences in bi-manual dexterity of Latin and American children *Child Develop*, 1930, 1, 204-231

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L'EFFET D'ÉTUDIER DANS UNE ÉCOLE DE LANGUE ÉTRANGÈRE SUR L'APPRENTISSAGE DE LA LECTURE

(Resumé)

Dans les Iles Hawaiennes, où l'on a fait cette étude, beaucoup d'enfants étudient chaque année dans deux écoles, les écoles de l'Etat, où on les enseigne à lire l'anglais, et les écoles japonaises ou chinoises, où ils étudient une langue orientale écrite d'un sens différent de l'anglais, verticalement et de droit à gauche. Cette étude essaie de decouvrir l'effet de cet effort d'apprendre à lire en même temps deux langues si différentes et aussi laquelle de ces différentes directions de lecture est la plus naturelle pour l'enfant qui ne sait pas lire.

Dans ce but on a fait un test où l'on donne un nom à vingt-cinq tableaux placés dans un carré Les sujets employés ont inclu 634 enfants âgés de deux à neuf ans et 115 adultes Les résultats du test ont montré une corrélation avec la direction preférée de lecture des adultes

Les résultats pour l'ordre naturel de la lecture n'ont pas été conclusifs mais ils ont indiqué une tendance chez le petit enfant à commencer au coin droit en bas de la page, à suivre le bord de la page ou la direction horizontale plus souvent que la verticale, et à renverser les directions dans les lignes alternées.

Les elèves des écoles de langue etrangère ont eu des résultats moins élevés dans les tests standardisés de lecture que les autres enfants orientaux, et l'étude de leurs erreurs semblent indiquer une vraie confusion de l'orientation chez eux laquelle est probablement un facteur de leurs progrès plus lents dans la lecture.

SMITH

DIE EINWIRKUNG DER BESUCHUNG EINER SCHULE MIT FREMDER SPRACHE AUF DIE BEMEISTERUNG DES LESENS

(Referat)

In den Hawaiier Inseln, wo diese Untersuchung durch gefuhrt wurde, betreten jedes Jahr eine grosse Zahl von Kindern zwei Schulen—die offentlichen Schulen, worin sie lernen, Englisch und Japanesisch zu lesen, oder Chinesische Schulen, worin sie eine morgenlandische Sprache studieren, die im Schreiben gerade das Gegenteil sur Englischen Sprache darstellt, da sie vertikal und von rechts nach links geschrieben wird. In dieser Untersuchung wird der Versuch gemacht, die Einwirkung zu bestimmen von diesem Versuch, zu gleicher Zeit zwei so verschiedene Sprachen lesen zu lernen, und auch zu ertorschen, welche dieser verschiedenen Leserichtungen dem im Lesen ungebildetes Kind am naturlichsten ist

Zu diesem Zweck wurde eine Prufung mit Bildernennung (picture naming) erfunden, worin 25 Bilder in ein Quadrat geordnet waren Als Versuchspersonen dienten 634 Kinder im Alter von 2 bis 9 Jahren, und 115 Erwachsene Die Testbefunde erwiesen eine (positive) Korrelation mit der bevorzugten Richtung des Lesens der erwachsenen Versuchsperson

Die Befunde in Bezug auf die naturgemasse Richtung des Lesens liesen keine Schluesse zu, wiesen aber auf eine Tendenz des kleinen Kindes hin, in der unteren Ecke des Blattes, und rechts, anzufangen, an der Kante des Blattes entlang zu gehen oder horizontal forzufahren, öfter als vertikal, und auf jeder zweiten Linie die Richtung umzuwenden

Die Versuchspersonen die die Schulen mit Auslandischer Sprache besuchten erzielten an standardizierten Leseprufungen (reading tests) niedrigere Zahlen als die anderen morgenlandischen Kinder, und eine Untersuchung ihrer Irrtumer schien bei ihnen auf eine bestimmte Verwirrung in der Orientierung hinzuweisen die vielleicht eine der Ursachen ihres langsameren Weiterkommens im Lesen darstellt.

SMITH

A STUDY OF THE LAUGHING AND SMILING OF PRESCHOOL CHILDREN*

From the Child Development Institute, Teachers College, Columbia University

Gladys F Ding and Arthur T Jersild

Why do we laugh and smile? This question has provoked many volumes of theory and a few empirical studies Speculation as to various causes of laughter has hitherto received more attention than experimental research. For this reason the subject still offers a fruitful field of investigation.

The present study[1] is based on observations of 59 Chinese children, ranging in age from two to five years Each child was observed four hours or more. The procedure was to record each laugh and smile as it occurred, and to make a note of the stimulus situation which confronted the child when the response was made. The purpose of the study was to investigate the conditions which cause laughing and smiling, to study the relationship between laughing and smiling and such factors as age, sex, intelligence, and other factors, to analyze individual differences so far as possible, and, in general, to compare empirical findings with prevailing theories in the field.

Theories of Laughter

If we disregard differences in the dialectic and terminology employed by different writers, the main theories of laughter may be summarized somewhat as follows.

Laughter is a form of derision We laugh because of the pleasure we feel in finding ourselves superior to someone else.

There are two kinds of laughter, laughing "with," and laughing

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[1]The authors are indebted to Dr. Lelah M Crabbs for help in planning the study, to Miss Jessie Roddy and Mrs Y K Chu, the teachers in charge of the school at which the study was made, and to Mrs. Pearl B Crawford, who made supplementary observations for use in studying the reliability of the data

The data were collected by the author first named, while the second author was responsible for the organization and writing of the study.

"at." The latter carries a sting and has its origin in malice and self-conceit.

Laughter results from a sudden perception of the incongruous in our surroundings.

We laugh because of contrasts in our environment.

It is the mechanical that causes laughter. The behavior of a human being is laughable in proportion as it reminds us of a mere machine.

We laugh because we are happy. Laughter arises from euphoria; it is an expression of sheer joy.

It is the absence of strain, the healthy and uninhibited functioning of bodily processes which give rise to laughter.

Laughter is a form of relaxation, a means of releasing surplus energy. If the organism is keyed to perform a certain action, or is prepared to meet a certain situation, the energies so mobilized find an outlet through laughter if the stimulus for action takes an unexpected turn or is suddenly withdrawn.

Laughter is a form of play. Like play, it is free activity entered into for its own sake.

Laughter is a vocal invitation to join in play.

Laughter is an expression of the play instinct.

Laughter is instinctive in origin, *per se*, and may take place without any accompanying emotion in early infancy, whereas later it is much modified by convention.

Laughter gives expression to instinctive sympathy.

Laughter is originally caused by tickling, and becomes associated with other stimuli through the principle of association or the conditioned response.

Laughter results from gratification of subconscious and repressed wishes suddenly released from inhibition.

Laughter is associated with love. The smile is an elaboration of the lip and mouth movements used in the nursing embrace; laughter, which comes later, arises when obstructions against love behavior are suddenly weakened or removed.

The laugh is a vocal signal, carried over from primitive times, telling that all is safe.[2]

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[2]Theories of laughter and smiling have been the subject of frequent reviews, so a detailed bibliography will not be given here. For general discussions and references, the reader is referred to Diserens (1), Eastman (2), Greig (5), Hollingworth (6), and Washburn (8).

Some of the above generalizations overlap, although each one represents at least one, and in some cases several, approaches to the explanation of laughter and smiling. In the ensuing paragraphs, empirical studies are briefly reviewed.

Empirical Studies

Diary records of individual babies, description of situations which provoke smiles and laughs, of the pattern of the early smile and laugh, and of developmental sequences comprise much of the early empirical literature on smiling and laughter The observations of Bell, Darwin, Preyer, Shinn, Perez, Sully, Rasmussen, Moore, Dearborn, Watson, Fenton, Sherman, and others have dealt with many phases of early laughing and smiling. Studies of the responses of individuals in groups, investigations made by means of the questionnaire, and observations of laughter and smiling in response to verbal, pictorial, tactual, and other forms of stimulation are reported by Hall and Allin, Washburn, Walker, Morgan and Walker

Reports as to the time of the appearance of the first smile differ with different writers M. C. Jones (7) found smiling in response to the stimulus of an adult bending over the child and making a sound at the age of 39 days. All of her subjects responded to this stimulus at the age of 90 days and over. It is generally agreed that smiles, presumably of a more reflex or mechanical character, appear a good deal earlier than this.

The laughter and smiling of 15 infants during the first year of life were studied by Ruth W. Washburn (8) The infants were observed at regular intervals. Various forms of stimulation, such as "chirruping," peek-a-boo, threatening head, hand-clapping, sudden reappearances from under the table, levitation, and surprise box, were used. The patterns of the infants' responses are described. Washburn found that laughter occurred later than smiling; that, following their appearance, laughing and smiling did not correlate significantly with chronological age, mental development, or physical condition The threatening-head stimulus was found to be most provocative of laughter, while smiling was more frequent in response to peek-a-boo and sudden reappearance from under the table.

The laughter of 17 children, aged 2 to 4, was studied by A. C. Enders (3) at the Merrill-Palmer School, under the direction of L M Crabbs Enders observed laughter as it took place under normal conditions as well as in response to controlled stimulation. She found

that the four-year-olds had the highest laughter frequency, next came the two-year-olds, and last the three-year-olds Motion and sound, or a combination of the two, were most effective in causing laughter The children laughed more when with other children than when alone or with adults. In a study by Alice Gregg (4) 40 hours of observation were devoted to 22 nursery-school children. It was found that laughter occurred more frequently in connection with physical activity, and that children laughted more in social situations than when alone.

Procedure

In the present study no experimental factor was introduced save that of observing and recording the laughs and smiles that occurred during the free play and normal activities of children in a combined kindergarten and nursery school.

The children all belonged to a single group, enrolled under two teachers in a school in the Chinatown section of New York City The total membership of the school was 59 The main results of the present study are based on the records of 50 of these children, all of whom were of unmixed Chinese stock, American-born, and members of the school for at least three months prior to the beginning of the study The records on the remaining nine, three of whom were Eurasians (Chinese fathers, Irish mothers), and six of whom were newcomers at the school when the study was begun, were treated separately

In the group of 50 children, there were 9 two-year-olds, 9 three-year-olds, 13 four-year-olds, and 19 five-year-olds The children came from 41 families. Eleven of the fathers were relatively well-to-do business men; 24 of the fathers were salesmen or partners in small stores and restaurants, interpreters, or clerks in banks, the remaining 6 fathers were employed as waiters or as manual laborers, and were relatively poor

The school hours were from one to three in the afternoon This program of afternoon hours was governed by the prevailing mode of life among the parents, most of whom worked late in the evening and began work late in the morning

The program during the two hours at school offered much the same freedom and informality that are found in the usual kindergarten or nursery school. The children had a large play-room, provided with tables, benches, toys, a sand-pile, a slide, a teeter, and

space for play with wagons, blocks, and other materials There was no roof-garden or outdoor playground The children remained in this room during the two hours with no interruption save that of visits to the bathroom.

Observational Method. The investigator spent a long time in making preliminary observations. Various procedures were tried out, and records of all situations in which laughing and smiling occurred were made On the basis of this preliminary work a standard record-taking blank was devised.

It was decided to observe each child on two different occasions, separated by at least one month's time Each observation period began when the child arrived at one o'clock and lasted until he left at three Each child was accordingly observed approximately for four hours.

In addition to the regular schedule of four hours of observation of each child, ten of the children were further observed for another period of four hours, divided into two separate two-hour intervals, for the purpose of checking upon the reliability of four hours of observation. Moreover, during the course of the study a second observer was introduced on occasions to take simultaneous and independent records as a further means of testing the reliability of the data.

The record blank which was devised on the basis of preliminary study made provision for two entries of each laugh and smile. Each response that occurred was numbered serially. The number which

ABBREVIATED SAMPLE OF DATA SHEET

	Voices S	Voices O	Social contacts	Speaking and spoken to Ch	Speaking and spoken to Adults	Motor activity Self	Motor activity Others	Music and Act	Music and Songs
Laugh	16,					1, 5, 6, 17	3, 18		
Smile			2, 10	4, 20	14	7, 9, 11, 19	8, 15	21	12, 13

1.05 P.M. 1, goes down slide, 2, looks at T, both smile, 3, ch. tries to put beads on her, 4, speaks to ch., 5, 6, runs and skips, 7, runs after ch.; 1.15 P.M. 8, watches ch. skip, 9, climbs slide, 10, holds ch.'s hand; 11, runs to piano; 1:30 P.M. 12, sings with ch., 13, same; 14, T. speaks to her, 15, tells ch. to sit down; 16, T. telling story imitates bear's voice; 2:00 P.M. 17, plays in sand, 18, watches ch. kick block; 19, same, 20, speaks to ch., 21, plays and sings *Ring Round Rosy* with ch.

Symbols *S*, self, *O*, others, *ch*, child or children; *T*, teacher

identified a particular response was entered under a heading on the record sheet representing the situation in which the particular response occurred. In addition, each response was briefly described in a note at the foot of the sheet. An abbreviated sample of the record sheet, and of the type of data on which the present study is based, is given above.

This sample illustrates the general procedure used in taking records In the mimeographed record sheets which were employed there were 20 captions (as compared with the 9 given in the sample) covering as many different situations These captions were printed at right angles to the main body of the sheet, and were ruled off into separate boxes throughout the length of the record. The various captions, and the situations which they covered, were as follows:

Pictures Child laughs or smiles when being shown or when examining pictures

Speaking and spoken to. (*a*) Child speaks to another child or to other children, or is spoken to by children (*b*) Child speaks to adult or is spoken to by adult

Child's own motor activity Child runs, skips, moves about, is active with arms or legs. (*a*) Without materials, apparatus, or toys; is simply on the go (*b*) With toys, materials, and apparatus

Motor activity of others. Child laughs or smiles when watching others run, play, etc., without participating overtly in the activity itself. (*a*) Others active with apparatus, materials, etc. (*b*) Others active without materials, etc.

Stories. Laughs or smiles while attending to teacher telling a story

Vocal sounds Outcries, imitations of sounds, vocal play; not used as language, but as expressive reactions or independent vocal activities. (*a*) Made by self. (*b*) Made by others.

Non-vocal sounds Noises, bangs, tapping, etc (*a*) Made by self (*b*) Made by others

Moving things Child watches object in motion; blocks tumble, wagon runs down incline; etc.

Laughing, crying, or smiling persons Child responds to laugh, smile, or cry of other persons without having observed or participated in the situation which caused the other persons to respond.

Non-verbal social contacts. Child has contacts with others, holds hands, hugs, kisses, laughs or smiles spontaneously in greeting or meeting the gaze of another

Alone and passive Child exhibits no overt activity, sits or stands apart from group

Music and motor activity. Child is active on his feet, sways or claps his hands while music is being played or sung

Music and songs Child sits still and participates in group singing under direction.

Awkwardness, clumsiness. Child falls, stumbles, is unsteady on his feet, trips, etc. (*a*) Child himself (*b*) Others.

Child being "funny," clownish Child himself or others strut with cap pulled down over eyes, grimaces, acts "silly," etc (*a*) Child himself (*b*) Others.

The items outlined above represent fairly well-defined categories, although it is true that a given incident in the child's behavior might contain elements of more than one of the situations just described Whenever a child laughed with his back turned to the observer, or under circumstances which did not permit a ready judgment as to the stimulus which gave rise to his response, the item was not recorded The observer made no attempt to interpret the child's subjective state, only the objective features of the situation were taken into account when a response was entered under a given heading

Measurements of Reliability

Three procedures were used to obtain a measure of the reliability and accuracy of the observer's records. One procedure was that of self-correlation. The number of laughs and smiles recorded during the first two hours of observation devoted to each of the 50 children was correlated with the results of the second two-hour observation period. The coefficient so obtained was $+.54 \pm .07$ (product moment).

In the case of 10 children, a total of 8 hours of observation was made. The correlation between the results of the first and the second four-hour periods was $+.89 \pm .04$ (rank difference)

A second method of finding reliability involved the use of a second observer This person was given instructions as to the procedure used in taking records, and thereupon the two observers took simultaneous but independent records of the child's behavior Eighteen periods of observation, each period 15 to 20 minutes long, were devoted in this manner to five children by the two observers

The agreement between the number of items thus recorded by the two independent workers was 95%. The experimenter had recorded 405 responses, while the second observer had recorded 387

More significant than this comparison is the question as to the agreement between the two observers in identifying specific laughs and smiles under the various headings of the record sheet. By virtue of the serial number given to each laugh and smile that was entered upon the record and described in the footnotes, it was possible to follow the course of the child's activity as set forth in the records and to find to what extent the two workers agreed in entering specific responses under similar headings of the record sheet. In order to count as a case of agreement, the response had to be identified in similar terms in the descriptive footnotes and also entered under the same heading on the record sheet.

Each pair of the 18 simultaneous observation records was examined according to this procedure. The agreement between the two observers was calculated in terms of percentages $\left(\frac{\text{total number of items of agreement}}{\text{total number of items recorded}}\right)$ The percentage of agreement in the eighteen cases was found to range from 70 to 100%, with an average agreement of 90%.

Still another, although less significant, procedure was used in checking upon reliability. The two teachers in charge of the children were asked to rate each child with respect to the relative frequency of his laughter and smiling. A four-point rating scale (A, B, C, D, where *A* = child laughs and smiles relatively very much; and *D* = laughs or smiles very little) was used. The experimenter, in turn, found each child's quartile rank in the observational records. The coefficient of contingency between the two series was 83± 12

Results

Table 1 shows the number of laughs and smiles observed in connection with each of the general situations covered in the study. The figures are based on the results of a regular schedule of four hours of observation of each child plus four additional hours devoted to each of ten of the children. The results of the supplementary 40 hours of observation resembled the main body of data so closely that the findings for the entire 240 hours of record-taking are presented.

From Table 1 it appears that decidedly the greatest amount of laughter and smiling occurred in connection with some form of motor activity,

That the laughs occurring in connection with the child's own motor activity (including motor activity in response to music) out-

TABLE 1

SITUATIONS PROVOKING LAUGHING AND SMILING, AND NUMBER OF LAUGHS AND SMILES RECORDED FOR EACH SITUATION DURING 240 HOURS OF OBSERVATION OF 50 CHILDREN

Stimulus situation	Laughs	Smiles	Total
Child's own motor activity	398	1786	2184
a. With materials, toys	(186)	(822)	
b Without materials, toys	(212)	(964)	
Motor activities of others	139	1034	1173
a With materials, toys	(59)	(444)	
b Without materials, toys	(80)	(590)	
Speaking and spoken to	97	1328	1425
a. Child and child	(84)	(792)	
b Child and adult	(13)	(536)	
Music and motor activity	76	345	421
Non-verbal social contacts, hugging, etc	26	676	702
Music and singing	5	141	146
Being "funny," clownish	21	31	52
a Child himself	(8)	(11)	
b. Others	(13)	(20)	
Non-vocal sounds	15	52	67
a. Made by child himself	(15)	(35)	
b. Made by others	(0)	(17)	
Vocal sounds	7	19	26
a Child himself	(1)	(8)	
b. Others	(6)	(11)	
Stories	8	27	35
Pictures	9	69	78
Alone, inactive	1	52	53
Laughing, smiling, and crying persons	2	37	39
Awkwardness, self and others	5	10	15

number the laughs occurring in connection with all other situations combined,

That smiling occurs approximately seven times more frequently than laughing (total laughs, 280; total smiles, 5644),

That there are relatively more smiles, relatively fewer laughs, in connection with social situations than in connection with the child's own motor activity;

That laughing or smiling did not occur frequently in response to hearing or seeing another smile or laugh, or in response to seeing another cry or stumble and fall or behave in an awkward manner

The results seem to indicate that the child's laughing and smiling are a rather free accompaniment of his general activity. There is no evidence that special conditions, such as derision, response con-

ditioned by early tickling, elaboration of love behavior, release from repression of subconscious desires, and similar factors which have been set forth in theories of laughter have any outstanding efficacy in provoking a child to laugh or smile. To be sure, the investigator who merely records each situation as it strikes the eye has no way of probing the child's subjective state or of detecting the effects of previous training and conditioning Some general impressions with regard to the specific factors just named were obtained, however, during the course of the observations These will be touched upon at a later point.

Table 1 gives a general picture of the child's behavior rather than a detailed analysis of the effectiveness of each stimulus situation. The high frequency of laughing and smiling observed in connection with motor activity no doubt arises partly from the fact that the child devoted a larger portion of his time to motor activity than to other pursuits For this reason we cannot say that motor activity alone, for instance, is more provocative of laughter than motor activity in response to music, since only a limited time was devoted to music Likewise, the children had more occasion to speak to one another than to speak to the two adult teachers, so a higher frequency of laughter for the former situation would be expected Even so, the table reflects the variety of situations which cause the child to laugh or smile during the course of his free activity in a nursery school

It was observed throughout the course of the study that the children who were most ready to laugh and smile were also more active in their play The records do not contain an itemized account of each move made by each child while he was under observation, but the footnotes of the record sheet of each child do give a picture of his gross movements from place to place and of his changes from one activity to another These records support the observation that the children who exhibited the greatest amount of energy also showed the highest laughter and smiling frequencies More will be said concerning individual differences in later discussion It is pertinent at this juncture, however, to comment briefly on the high association between motor activity and laughter and smiling.

The objective data compiled in this study, supplemented by general impressions obtained during the study, lead the authors to the opinion that in many instances the laugh and the smile do not reflect the operation of a peculiar stimulus but simply reflect a state of

general body activity on the part of the child. The child who makes free use of his arms and legs is also likely, at the same time, to use freely the muscles involved in producing the laugh and smile. The activity of the latter muscle groups is a part of the general picture. For this reason, the explanation of responses of this kind should be sought not by inquiry into the occasion for the specific laugh or smile but by inquiry into the factors which underlie the child's general physical activity. Stated in somewhat figurative terms, the abundance of energy which determines the child's use of his arms and legs in spontaneous activity overflows incidentally into the muscle groups which are active in the laugh or smile

To be sure, the laugh and smile may occur on many occasions when physical activity is not prominently in evidence The fact that the child laughs and smiles more readily when in the company of other children than when alone, that he may smile simply when meeting or greeting another person, and that some specific situations are more closely associated with laughter than others, would indicate that a single hypothesis of laughter will not suffice to cover all the situations in which the response may occur

As might well be expected, the children differed widely in the frequency of their laughter and smiling. One child averaged 62 smiles per hour while he was under observation, while at the other extreme there was one child who had an average of only 3. Three children laughed an average of 8 times per hour, while eight children exhibited no laughter at all. Table 2 shows the distribution of average numbers of laughs and smiles per hour exhibited by different children during four hours of observation of each child

TABLE 2

DISTRIBUTION OF AVERAGE NUMBER OF LAUGHS AND SMILES PER HOUR RECORDED DURING FOUR HOURS OF OBSERVATION OF EACH OF 50 CHILDREN

Smiles per hour	No children	Laughs per hour	No children
0- 9	6	0	8
10-19	16	1	10
20-29	18	2	8
30-39	7	3	8
40-49	1	4	5
50-59	0	5	3
		6	1
60-69	2	7	4
		8	3

No figures directly comparable with the averages in Table 2 can be found in other studies of white children. Gregg (4) reports an average of about 1.30 laughs per hour from her observations on nursery-school children. This average is lower than the figure obtained in the present study on children of a wider age range. Enders (3) reports average number of laughs per day for each age level represented in her study. The averages are lower than those obtained in this study, but the authors do not have at hand the necessary figures for making a comparison of number of laughs per hour.

Even though no direct comparisons can be made, it appears that the Chinese children used in this study laughed quite as much as the Caucasians studied by other investigators. This finding is rather interesting in view of the fact that Chinese adults have been regarded as being perhaps less given to expressive reactions than Caucasian adults.

Table 3 shows the average number of laughs and smiles per hour observed at each age level, separate averages are given also for boys and girls.

It appears in Table 3 that the three-year-old children had the lowest laughter and smiling frequencies. It is interesting that a similarly low laughter score is shown for three-year-old children in the study reported by Enders (3).

The table further shows that the boys laughed less frequently than the girls at all four age levels. On the other hand, the boys smiled more frequently than the girls at three of the four age levels. Due to the limited number of cases, and the high variability of the scores, these differences do not have significant statistical reliability. The rather consistent indication of more subdued expressive reaction on the part of the boys is, however, of some interest.

TABLE 3

AVERAGE NUMBER OF LAUGHS AND SMILES PER HOUR CLASSIFIED ACCORDING TO AGE AND SEX

Age in months	N	Total Laughs	Total Smiles	Boys N	Boys Laughs	Boys Smiles	Girls N	Girls Laughs	Girls Smiles
24-35	9	3.06	23.27	4	2.46	25.54	5	3.55	21.46
36-47	9	1.36	15.31	5	1.43	17.05	4	1.29	13.14
48-59	13	2.21	23.02	6	1.73	24.36	7	2.60	21.92
60-71	19	3.92	23.59	11	3.29	23.51	8	4.87	23.71
Av.	(50)	2.86	21.90	(26)	2.44	22.77	(24)	3.34	20.96

In Table 4 age differences in laughter and smiling are treated from the point of view of the stimulus The table shows the percentage of the number of laughs and smiles observed during 36 hours of observation at each age level that occurred in response to each of the various stimulus situations Thus, the figure 54, which appears first in the table, indicates that 54% of the laughs recorded during observations of the two-year-old children occurred in connection with the child's own motor activity. Some of the situations which were treated separately in an earlier table are here combined under more inclusive headings.

In Table 4 it appears that motor activity is the most frequent occasion for laughter and smiling at all age levels. There is evidence, however, that at the five-year level motor activity is relatively less effective than at earlier years, while the situations "speaking and spoken to by children," and "music and motor activity" are more significant at this age than in earlier years.

TABLE 4

PERCENTAGE OF TOTAL NUMBER OF OBSERVED LAUGHS AND SMILES PROVOKED BY EACH OF THE VARIOUS SITUATIONS DURING 36 HOURS OF OBSERVATION AT EACH AGE LEVEL

Situation	Laughs				Smiles			
	2 yrs.	3 yrs	4 yrs	5 yrs.	2 yrs	3 yrs	4 yrs	5 yrs.
Child's own motor activity	54	58	56	39	34.0	33 0	30.4	29 0
Motor activity of others	25	16	21	17	21 0	23 0	21 4	18 0
Speaking and spoken to by children	5	4	7	13	8 0	11 0	16 0	16 0
Speaking and spoken to by adults	2	0	0	1	6 0	7 0	7 0	10 0
Non-verbal social contacts, embraces, etc.	2	4	4	4	19.0	15 0	10 0	11.0
Music and motor activity combined	4	0	7	15	2.0	3 0	6 0	8 0
Music and singing combined	0	0	0	2	1 0	3 0	2 0	3 0
Laughter, smiling and crying of others	0	2	0	0	4	1 0	1 0	5
Moving things	0	0	1	2	1 0	1 0	1 7	4
combined	0	0	0	1	1	1 6	2.0	1 6
Stories	0	2	1	0	2	3	1.0	3
Being "funny", grimacing; awkwardness, self and others	8	0	2	3	6	0 0	5	4
Sounds, noises, including vocal, self and others	0	14	1	3	1 4	3	6	1 6
Alone, unoccupied	0	0	0	0	5 0	1 0	4	2

The results shown in Table 4 suggest a partial, although not unequivocal, explanation of the higher laughter frequencies at the two-year as compared with the three-year level The younger children show a somewhat higher percentage of their laughter in connection with situations involving other persons This conforms to an impression which the observer frequently gained during the course of the study. The older children tended, on the whole, to be more active on their own initiative than did the younger ones, but, at the same time, there was a tendency on their part to favor the smaller children with their attentions The small two-year-olds were often taken by hand and played with by the older children, and apparently were made to feel more at home and more free to express themselves. The three-year-old children were not as often babied in this manner, on the one hand, nor were they always capable of holding their own against the older children The writer is of the opinion that this impression comes nearer to explaining the differences between the two- and three-year laughter and smiling records than any assumption that there is an intrinsic difference between children at these ages.

Correlated Phenomena

The data obtained from the observations, supplemented by other records and measurements, gave opportunity for a few interesting correlations

The Correlation between Laughing and Smiling The foregoing tables have already indicated a tendency toward correlation between laughter and smiling frequencies so far as the stimulus situations and the age and sex groupings are concerned. The relative proportions of laughs and smiles differ substantially, however, when different situations are compared Thus, there is a relatively higher proportion of laughter in response to motor activity, and a relatively higher proportion of smiles in connection with social contacts and conversation. The further question arises, what individual differences are there in the proportions of laughs and smiles? Does one child smile much and laugh little, while another laughs much and smiles little? To answer this question, the laughing and smiling frequencies recorded for each of the fifty children during four hours of observation were correlated The resulting coefficient was 65 $\pm$ .06 This coefficient is fairly high and would seem to indicate that, so far as the individual is concerned, the child who laughs much

tends also to smile much. It would be interesting to find whether the same relationship obtained in the case of adults.

Laughter as Related to Age. The tables have shown a tendency toward higher frequency of laughter and smiling at the five-year level, low frequency at the three-year level, and little difference between the two- and the four-year-olds. The same lack of any noteworthy age relationship is seen in the correlation between laughter frequency and age, which gave the low coefficient of $.27 \pm 09$.

Laughter and Height. The correlation between these two factors was also low, $r = 06$. This indicates a negative correlation between laughter and height with age constant, and would seem to show that in the case of the children used in this study laughter does not occur more frequently among children who are tall for their age than among those who are relatively undersized. (The correlation between height and age was 72; the partial correlation between laughter and height, age held constant, was —.17.)

Laughter and Height-Weight Ratio. These factors were correlated in a further attempt at finding a relationship between laughter and physical build. The coefficient was negligible ($+ 04$).

Laughter and Intelligence. It was rather difficult to obtain intelligence ratings of the children, due to language handicaps. Several tests were tried out, on varying numbers of children. It was found that the Van Alstyne Picture Vocabulary Test could be used with the greatest number of children. Chinese terms were substituted for English words. The children who were too young or too old to qualify for the test were eliminated. There remained 26 children to whom the test was given. The median CA of these children was 50 months, the median MA obtained on the test was 49 months. It will be recognized that the intelligence measurement was not as adequate as it might be. The correlation between mental age and number of laughs was insignificant ($+.22 \pm 12$, as compared with a correlation of $+ 26$ between laughter and chronological age.

Laughter as Related to Nutritional Status. The children were given health examinations twice a year. On the examination cards prepared by the visiting doctors each child was rated I, II, or III, according to his nutritional status. There ratings were correlated with the number of laughs, and the resulting coefficient was $+.23 \pm 10$. The limitations of a coefficient so low, and based on a series containing only three intervals, will be recognized.

Laughter and Socio-economic Status. An attempt was made to

rate the home of each child on such points as income of the father, number and size of rooms in the home, general living conditions, cultural conditions, etc. Due to the exploitation of Chinatown by sight-seeing enterprises, the inhabitants are on guard against inquiry into their private lives, so that data for these ratings were difficult to procure The correlation between frequency of laughter and the socio-economic ratings that were obtained was negligible ($r = -.07$.)

Incidental Observations and Case Studies

Even though an investigator may try to steer clear of subjective factors in a study such as this, no one can devote 240 hours of observation to a group of children without obtaining many impressions which are of scientific interest. A variety of such impressions, supplemented by quantitative data, follow.

Behavior of Eurasians and of Children Who Had Recently Joined the Group Separate records were made of the three Eurasians and of the six children who had come to the school only a short time before the study was begun. The Eurasians (who had Chinese fathers and Irish mothers) seemed to be at a distinct disadvantage. Two of the three were brothers, so they could play with one another, even though the group as a whole would not receive them The third child, who had neither kin nor friend at the school, had to play by himself most of the time. The two brothers sometimes laughed heartily in their play with one another, but the other children took no notice of their laughter The third child would sometimes act "silly," apparently in an effort to win the attention of other children, but he seldom succeeded

The six children who were newcomers at the school had a somewhat similar situation to face during the early part of their stay. Among the six there was no single laugh, and only a few smiles during the first two hours of observation of each child.

Identical Twins A and B had all the outward appearances of identical twins They were indistinguishable to the teachers who had known them for a year, and when the observer took her records, she had to tie a ribbon to the arm or hair of the particular twin whom she was observing. The two were constantly together. Even though two cases cannot support any general conclusions, the comparative measurements of the twins are of some interest. Below (Table 5) are given the laughing and smiling scores of the two, and certain other measurements

TABLE 5

COMPARISON OF TWO TWINS IDENTICAL IN APPEARANCE

Name	C A.	No of laughs	No of smiles	Merrill-Palmer MA	Kuhl-mann MA	Drawing Test	Van Alstyne	Height in.	Weight lb
A	45	14	130	51 mo.	37.5	66	42	41.13	31.8
B	45	4	90	50 mo.	49.5	refused	45	42.25	33.5

The comparisons in Table 5 indicate that the twins were considerably less identical in actual measurements than in general appearance. Twin B, in addition to being somewhat taller and heavier than A, was regarded by the teachers as having a somewhat more healthy complexion than A Yet A scored considerably higher in laughing and smiling, even though the conditions surrounding the two were almost identical by reason of their close companionship.

Siblings. There were many siblings in the group of children, among them were four who belonged to the same family. These four attracted attention by reason of the infrequency of their laughs and smiles. The children ranged in age from 68 to 26 months. The two youngest siblings did not exhibit a single laugh during four hours of observation; the oldest laughed only twice, and the next oldest only once The investigator received permission to observe these children in their home. The same absence of laughter was noticed there There was no evidence of especially rigid discipline or of nagging in the home The family lived in rooms adjoining the father's jewelry store. It was noticed that when the children moved about in the store, or played in the nursery, they were very reluctant to pick up toys or other objects It is possible that the children had been trained very early to move cautiously among the jewelry cases at home, and that this training influenced also their behavior in the nursery school.

Sympathetic Laughter As indicated in a foregoing table the children sometimes laughed or smiled upon observing another child laugh without, apparently, having watched or participated in the situation which caused the other child to laugh. The responses in this category were relatively few in number From another point of view, however, the factor of sympathy appeared to be somewhat significant Children were observed to laugh or smile more readily

at the activities of their brothers or sisters or of friends than at the antics of children with whom they had not associated closely.

Derision. There was practically no evidence that derision or a feeling of superiority are responsible for children's laughter. The awkwardness of others, of a kind which is supposed to provoke laughter in the adult, seemed to have little effect on these youngsters. When a child tripped, fell off an object, tumbled over while running, or stumbled in his play, the other children did not seem to regard the episode as funny. There was a crippled boy in the group who had a hard time in keeping his balance while walking. The other children sometimes watched him, but showed no inclination to laugh or smile at him. New children who arrived when the study was in progress likewise showed no tendency to laugh or smile at him when they observed his unsteadiness for the first time. The boy himself, however, would frequently smile when he noticed that someone had seen him stumble. On no occasian was a child who had previously been deprived of a toy or otherwise dominated by another observed to laugh when his competitor tumbled or came to grief.

Motor Activities as Related to Laughter and Smiling. The high frequency of laughter and smiling associated with motor activity has already been stressed. When the children were romping about, playing with toys and materials or simply running and kicking their heels, then laughter and smiling gave the impression of being simply a natural accompaniment of their behavior. The response which occurred when the child was playing on the slide usually took place only after he reached the floor at the end of his descent. This observation lends some support to the view that laughter is an outlet for pent-up energies.

Music. When lively music was played, the children laughed and smiled profusely. If the children were seated, they would often begin to clap their hands, and the more aggressive ones would leave their seats and romp about the room. The laughter in response to music was usually accompanied by more overt activity.

Crying. The original plan of this study was to investigate crying as well as laughing and smiling. This plan was carried through, although it soon became apparent that the data on crying would be very limited. During the entire 240 hours of observation only 16 instances of crying occurred. Nearly all of the crying took place when the child was struck by someone else, or deprived of his toys, or pushed over and caused to fall. When the child stumbled or fell

or otherwise appeared to hurt himself when he alone was responsible no instance of crying was observed. The crying that was observed seemed to rise more from resentment of the deeds of others than from actual pain to self.

Summary and Conclusions

The present study is based on 276 hours of observation of 59 children, members of a Chinese nursery school and kindergarten, ranging in age from two to five years. Each laugh and smile was recorded in terms of the situation in which it occurred The purpose of the study was to find the occasions which give rise to children's laughter and smiling, to study individual differences, age differences, and to study factors associated with children's laughing and smiling.

It was found that laughter and smiling occurred most frequently in association with general motor activity; that the three-year-old children responded somewhat less frequently than the children of two, four, and five years; that smiling occurred approximately seven times more frequently than laughing, that the laughing and smiling occurring when the child was physically active at play outnumbered the responses observed in all other situations combined, that the older child responds somewhat more frequently to social contacts and to music than does the younger child

The children laughed and smiled more frequently when observing their brothers or sisters or close friends than when in company with strangers; children who were newcomers at the school responded very little, there was evidence that Chinese children laugh and smile quite as much as Caucasians who have been studied by other investigators.

Marked individual differences in frequency of laughter and smiling appeared The frequencies bore no significant relationship to age, intelligence, nutritional status, height, weight, or socio-economic status.

The girls showed a somewhat higher laughter frequency at all age levels, while the boys exhibited a greater number of smiles than the girls at three of the four age levels included in the study. The reliability of these differences was not substantial, however

There was no evidence to support the view that laughter represents a feeling of superiority, or of derision; or that tickling, release from repression, perception of the incongruous or of the mechanical,

or love behavior, or other special factors stressed in theories of laughter have any outstanding efficacy in causing the response. Some instances of laughter in response to apparently deliberate attempts at being funny were observed, but these were infrequent.

On the whole, it appears that the laughing and smiling of children from two to five occur predominantly in connection with general physical activity The laugh and the smile apparently serve, in large measure, as a motor outlet in response to many forms of stimulation. The fact that the child responds more frequently when in the company of others than when alone no doubt arises in part from early social conditioning, in part from the increased stimulation to general activity provided by the presence of other individuals.

References

1 DISERENS, C M Recent theories of laughter *Psychol Bull*, 1926, **23**, 247-255

2 EASTMAN, M The sense of humor New York & London Scribner's, 1921 Pp. 257

3 ENDERS, A C A study of the laughter of the pre-school child in the Merrill-Palmer Nursery School *Papers Mich Acad Sci, Arts & Letters*, 1927, **8**, 341-356

4. GREGG, A An observational study of the laughter of three-year-old children Master's thesis, Columbia University

5 GREIG, J Y T The psychology of laughter and comedy New York. Dodd, Mead, 1923. Pp 304

6. HOLLINGWORTH, H S. Judgments of the comic *Psychol Rev*, 1911, **18**, 132-156

7. JONES, M C The development of early behavior patterns in young children. *Ped Sem*, 1926, **33**, 537-585

8. WASHBURN, R. W A study of the smiling and laughing of infants in the first year of life *Genet Psychol Monog.*, 1929, **6**, 397-537.

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UNE ÉTUDE DU RIRE ET DU SOURIRE DES ENFANTS D'ÂGE PRÉSCOLAIRE

(Résumé)

On a étudié le rire et le sourire de 59 enfants chinois, âgés de 2 à 5 ans On a observé chaque enfant quatre heures ou plus. On a fait une notation de chaque réponse et de la situation devant l'enfant quand il a ri ou souri

On a trouvé que le rire et le sourire arrivent le plus fréquemment avec l'activité motrice de l'enfant Les enfants ont ri et souri plus avec des

compagnons amicaux que seuls ou avec des inconnus Les enfants de trois ans ont ri et souri moins fréquemment que les enfants d'autres âges Une comparaison entre ces résultats et les autres résultats publies suggère que l'enfant chinois rit et sourit aussi fréquemment que l'enfant caucasien Les filles ont tendu à rire plus, et à sourire relativement moins que les garçons, mais la constance de la différence a éte peu elevee On n'a trouvé aucune corrélation significante entre la fréquence du rire et du sourire et de tels facteurs que la taille, le poids, l'ètat de nutrition, ou l'âge mental. Il n'y a eu aucune évidence que de tels facteurs que le chatouillement, le comportement d'amour, le relâchement de la repression, la derision, l'incongruité et d'autres conditions données dans les théories du rire possèdent un pouvoir spécial de causer le rire ou le sourire Des grandes différences individuelles, même entre les enfants elevés dans des conditions qui semblent pareilles, suggèrent l'effet d'un conditionnement anterieur et des idiosyncrasies personnelles non étudiees

DING ET JERSILD

EINE UNTERSUCHUNG DES LACHENS UND DES LACHELNS VORSCHULPFLICHTIGER KINDER

(Referat)

Es wurde das Lachen und Lacheln von neun-und-funfzig Chinesischen Kindern im Alter von 2 bis 5 Jahren untersucht Jedes Kind wurde vier Stunden lang oder langer untersucht Es wurde eine Notierung gemacht uber jede Reaktion und uber die Situation der das Kind gegenuberstand, jedesmal, dass ein Lachen oder ein Lacheln stattfand

Es zeigte sich, dass Lachen und Lacheln am haufigsten im Zusammenhang mit der motorischen Tatigkeit des Kindes stattfand Die Kinder lachten und lachelten in der Gesellschaft freundlicher Spielgenossen haufiger als wenn sie allein oder unter Fremden waren Die drei-jahrigen Kinder lachten und lachelten seltener als Kinder in anderen Lebensaltern Vergleiche zwischen den gegenwartigen Befunden und anderen veroffentlichten Daten weisen darauf hin, dass das Chinesische Kind ebenso haufig lacht und lachelt wie das Kaukasische Die Madchen erwiesen eine Tendenz, haufiger zu lachen und relativ seltener zu lacheln als Knaben, aber die Zuverlassigkeit des Unterschiedes war gering Es zeigte sich keine bedeutsame Korrelation zwischen Haufigkeit des Lachens und Lachelns einerseits und Elementen wie Grosse, Gewicht, Ernahrungszustand, oder geistiges Alter (mental age) Man fand keinen Beweis dafur, dass Elemente wie das Kitzeln, liebhaberisches Benehmen, die Befreiung von Unterdruckungen (repressions) der Spott, die Inkongruitat und andere Umstande die in Theorien des Lachens erwahnt worden sind bei dem Hervorrufen des Lachens oder des Lachelns besonderes wirksam sind. Die grossen individuellen Unterschiede, auch unter Kindern, die unter augenscheinlich ahnlichen Umstanden erzogen worden waren, weisen auf die Einwirkung vorhergehender Bedingung (conditioning) und unerforschter personlicher Idiosyncrasien hin

DING UND JERSILD

A STUDY OF THE READING AND READING INTERESTS OF GIFTED CHILDREN*

From the Psychological Laboratories of Northwestern University and Ohio University

PAUL A WITTY AND HARVEY C LEHMAN

There has been in recent years considerable careful study of mentally superior children Genetic studies of such children have been made by Terman, Hollingworth, and others during the last decade (11, 6, 1).

The writers have attempted to answer some of the questions arising from the speculation regarding gifted children Fifty gifted children (IQ 140 or higher) were identified, and the following information was assembled for each child

1. National Intelligence Test. Scales A and B, Form I
2. Stanford Revision Binet-Simon Intelligence Test.
3. Stanford Achievement Examination (Educational Attainment) Advanced, Form A
4. Overstatement Tests. [Two tests were devised to measure: (1) honesty in school situations and (2) a tendency to overstate knowledge.]
5. A test of versatility of play interests (Lehman Play Quiz and supplementary data)
6. Physical measurement of height and weight and record of physical development
7. Extensive home information including data upon early development, family history, interests and aptitudes for each child. (Parents rated the children upon social and moral traits)
8. Extensive school information including ratings by teachers and records of school progress
9. Reading interest and activity.

Forty-one children of IQ 140 and above were selected from the public schools in Kansas City, Missouri Nine children of the desired standing were found in Lawrence, Hutchison, and Baldwin, Kansas The children in Kansas City were identified by testing all children in Grades III-VII, inclusive, who fell in the 100 percentile

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on the National Intelligence Test, and including only those who scored 140 IQ or above on the Stanford Revision of the Binet-Simon Intelligence Test.

The original study of 50 gifted children was made in 1924-1925 Follow-up information was secured from time to time, and in 1929-1930 a rather detailed study was again made Comparison of the standing of the group in 1924 and 1929 has already been published (14) The group included 26 boys and 24 girls. All children were in Grades III-VII inclusive when they were first tested. The 50 children in the 1924 study were paired according to sex, age, and race with 50 normal children (IQ 90-100). A control group thus was provided and comparisons were made with the gifted group.

During the months of March and April, 1929, the follow-up investigation was started. Data were obtained by means of *questionnaires* and *objective tests* The children were studied in the following respects

1. Physical development and health
2. School record
3 General information
   a) Social and moral traits
   b) Activities in and out of school
   c) Abilities, talents, and interests
   d) Future plans

One phase of the study dealt with reading. The purpose of this paper is to present detailed information regarding the reading and the reading interests of the children. It is first desirable for the reader to know something of these unusual children. Table 1 gives the MA, CA, and IQ of each child These data were secured in 1924 Some of the outstanding characteristics of the gifted group, revealed by the 1924-1925 study, follow.

1. The gifted group has IQ's 140-183. The mean IQ of the entire group is 152, the means for the boys and girls fall in the same class interval IQ 150-155.

2. The physical status and general growth of the group are undoubtedly above average Typically, the gifted child is not a physical weakling. He is somewhat above normal in his physical development when compared with unselected children of the same CA. In most tasks requiring motor intelligence, he exhibits superiority He approaches the norms for the average child more closely in physical traits and motor ability than in mental ability.

TABLE 1

DISTRIBUTION OF FIFTY GIFTED CHILDREN ACCORDING TO GRADE, CA, MA, AND IQ (1924)

	School grade	CA	MA	IQ		School grade	CA	MA	IQ
1	6-A	135	234	173	26	5-A	116	162	140
2	6-A	130	217	167	27	5-B	108	198	183
3	6-A	124	207	167	28	5-A	107	194	181
4	7-B	127	210	165	29	5-A	121	206	173
5	7-B	144	234	163	30	6-A	126	214	170
6	7-A	136	222	163	31	4-A	110	176	160
7	5-B	115	186	162	32	4-A	99	156	157
8	7-A	127	200	157	33	5-A	130	202	155
9	4-A	115	179	156	34	5-A	131	202	154
10	5-A	122	189	155	35	4-A	108	166	154
11	6-A	141	213	151	36	5-A	129	198	153
12	5-A	111	180	151	37	5-B	116	177	152
13	5-B	118	178	151	38	5-A	130	197	151
14	4-A	101	152	150	39	8-A	137	205	150
15	5-A	127	189	149	40	7-A	137	205	150
16	7-A	146	216	148	41	6-B	123	185	150
17	5-A	128	190	148	42	4-B	108	163	150
18	5-A	126	185	147	43	5-B	113	169	150
19	4-A	121	178	147	44	4-B	117	175	149
20	4-A	112	164	146	45	5-A	128	189	147
21	4-A	147	194	143	46	5-B	114	168	147
22	7-A	148	208	141	47	6-A	131	191	146
23	7-A	154	216	140	48	7-A	147	210	143
24	7-A	151	212	140	49	5-A	130	185	142
25	7-A	152	212	140	50	8-B	154	216	140

3 There is a marked excess of English, Scotch, and Jewish stock represented. These data corroborate Terman's results (11)

4. Most of the children have had the advantages of stimulating *cultural influences in the home. The average amount of formal* education of the parents is thirteen years; the average annual income of the parents is $3200, and in most of the homes newspapers, magazines, and books are abundant This is, of course, not true in all cases The boy who earned the highest IQ and who also made the highest vocabulary score came from the humblest home He used the library constantly and learned to read at four years of age. The fathers of the gifted group are engaged in business and professional pursuits mainly, and are considerably above the average in their various occupational groups in success. The ancestry of the children holds numerous scientists, statesmen, educators, and writers of note.

5. The mean IQ of the group is 152; the mean EQ is 136, and

the mean progress quotient, 116. The unjustifiable educational retardation shows the inadequacy of the present school organization in taxing the superior mental capacity of the gifted child The excess in educational achievement above the norm is *general* rather than special. The most outstanding achievement of the group is in reading; poorest attainment is found in handwriting[1] and spelling.

6. The interests of the children reflect general superiority. Versatility and vitality of interest characterize this group The children engage in the same number of play activities as do average children, but they are somewhat more solitary and sedentary in their play.

7. In ratings of character and in scores on objective tests, the gifted child exceeds the average child to a marked extent. The tests are admittedly inchoate, and the ratings are somewhat unreliable

The 1929-1930 study brought out the following facts.

1. The gifted child's IQ now is lower than it was in 1924-1925[2] Nevertheless, he still exhibits superior mental ability The IQ's now obtained by the Terman Group Test range from 121-180, mean 136. The coefficient of correlation between the original individual mental ages and group measures of intelligence is $+.66 \pm .05$.

2 The average progress quotient of the group now is 112; at the time of the first study it was 116. The school apparently is making little effort to provide adequate educational opportunity for this group. Acceleration which has been urged by Freeman (4) and Gates (5) is not practised Little effort is made to enrich the curriculum for the gifted group, and no child of the original group is now in a special opportunity class

3 In spite of the failure of the school to experiment or to provide enrichment, the gifted child continues to maintain a high level in general information.

4 Failure to respond well to discipline has increased during the interval, and the boys are decidedly worse offenders than the girls Several of the children are considered difficult to manage[3]

5. The children display vocational interests at the present time which are more consonant with their ability than those exhibited

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[1]Gifted children have usually been found to do least well in handwriting This may be because gifted children are competing with children chronologically older

[2]For a six-year period Terman found an average drop of 9 points in the IQ's of gifted children (1, p. 25).

[3]Cf Hollingworth (7).

five years ago.[4] Furthermore, there appears to be a restriction of vocational interests, and sex differences are pronounced.

6 The gifted children participate generously in school life, and they carry academic honors somewhat more frequently than the control group.

The gifted children's reading interests were studied by three methods (1) the children's reports, (2) teachers' estimates, and (3) parental statements

The children were asked three times during 1924-1925 and one time only in 1929 to supply the information following·

1 How many hours per week do you spend upon reading which is not assigned in school?

2 Mark the kinds of book reading you most enjoy Rank 1, 2, and 3 the types you like best The rank (1) is to be given to the best-liked type *Three types only* are to be ranked.

a) Travel stories
b) Biographies
c) Novels (romance)
d) Novels (home or school life)
e) Novels (adventure)
f) Science stories
g) Short stories
h) Detective stories
i) Mystery stories
j) Autobiographies
k) Essays (general)
l) Essays (comical or satirical)
m) Myths or legends
n) Music or art books
o) Poetry

3 List the books you have read or have started to read *during the past week* (This information was requested upon Monday)

4 List the magazines you are reading and state which ones you like best (Magazine reading was studied only during the 1929-1930 investigation)

5 State approximately the number of books you have read during the past two months

[4]The writers have reported previously that there is a somewhat consistent tendency for boys to choose progressively occupations a little more closely related to their mental ages as they advance through the grades The writers have found also that there is a restriction of vocational interests with increased maturity See Witty and Lehman (15)

TABLE 2
AMOUNT OF TIME SPENT BY FIFTY GIFTED CHILDREN IN READING

		Hours per week Mean	Range
Teachers' judgment of gifted group	(1924)	8	2-12
Teachers' judgment of control group	(1924)	3	1- 8
Parents' judgment of gifted group	(1924)	9	2-12
Teachers' judgment of gifted group	(1929)	12	1-16
Teachers' judgment of control group	(1929)	5	0- 6
Girls' report (average of three investigations)	(1924)	6.5	1-12
Boys' report (average of three investigations)	(1924)	5 5	3-14
Girls' report	(1929)	8	0 5-20
Boys' report	(1929)	7 5	1-25

TIME SPENT IN READING

The averages of the three reports made in 1924-1925 concerning the number of hours spent upon reading were computed for the gifted and for the control groups. One similar report was obtained in 1929-1930 Table 2 sets forth the amount of time spent by the 50 gifted children in reading.

The average for the boys (who reported their leisure reading three times during 1924-1925) was 5½ hours per week; the range was 3-14 hours. For the girls, the average amount of time spent in voluntary reading was 6½ hours, and the range was 1-12 hours Noticeable indeed is the difference between the teachers' estimates of the time devoted by the children to leisure reading and the reports of the children. The teachers stated that the amount of reading which the gifted children engaged in would require an average of eight hours per week (1924-1925), while the amount of reading of the control group would require an average of 3 hours only per week. The teachers' estimates resulted from observation and subjective judgment of the children. These reports are probably less reliable than are the reports of the children. Each child stated the amount of time spent in reading in 1929-1930 The report was for one week only. The girls' average was 8 hours per week at this time and that of the boys 7.5.

Table 2 gives also the teachers' judgments of the amount of time devoted to reading by the gifted group of children in 1929-1930

According to the teachers, the amount of time spent each week in reading increased from an average of 8 hours to 12 hours during the five-year interval. These data are somewhat similar to those published by Terman (11) and by Cox (2). These estimates of the teachers (as well as those of the parents) are subject to an indeterminable amount of error. They are perhaps in excess of the true amount of leisure reading, due to factors such as the exceedingly rapid rate of reading among gifted children, the halo effect of superior mental ability upon judgments, and other items. The reports are of interest chiefly in corroborating the children's reports, and in revealing the increase in time devoted to leisure reading by gifted children as chronological age advances.

Both the teachers' estimates and the children's own reports indicate that the amount of time devoted to reading increased with advance in chronological age. This increase was not consistent with age, and the number of cases renders the finding unreliable. Burks, Jensen, and Terman (1) found "practically no dependence upon age within the age-range (13-18)" in their follow-up study of gifted children. For the 50 gifted children herein reported, there was a decided increase in amount of time devoted to reading between the first report (1924-1925) and the second report (1929).

Another feature of this study is of special interest. The estimates of the children regarding the number of books read were verified by the teachers' reports. The average number of books read in a two-month interval was 12 for the gifted and 5 for the control at the first testing. Five years later, the average for the gifted was 14; for the control, 6. All of the data give clear-cut evidence that the *voluntary reading of gifted children is extensive and exceeds greatly* the amount which mentally average children do. Additional but less reliable data are presented in Table 3, the teachers' reports of the comparative amount of leisure reading of gifted children.

TABLE 3

TEACHERS' REPORT OF COMPARATIVE AMOUNT OF READING OF GIFTED (1929)

Time spent	Percentage
Very much	24
More than average	46
Average amount	30
Less than average	0
Very little	0

TABLE 4
KIND OF READING ENJOYED MOST BY FIFTY GIFTED CHILDREN
Check list results Rank distribution

Type of book	Boys' ranks 1924-25	Boys' ranks 1929-30	Girls' ranks 1924-25	Girls' ranks 1929-30
Novels (adventure)	1	1	3	3
Novels (home or school life)	12	11	2	2
Novels (romance)	4	2	1	1
Detective stories	5	10	4	15
Mystery stories	2	9	5	6
Science stories	3	3	15	14
Biographies	6	4	9	12
Myths and legends	13	12	6	7
Essays (general)	7	5	10	4
Essays (comical or satirical)	15	6	14	8
Autobiographies	8	7	13	9
Short stories	9	13	7	13
Poetry	10	14	12	5
Drama	11	8	11	10
Music and art books	14	15	8	11

Table 4 displays the type of book reported as best liked by the gifted group both in 1924-1925 and in 1929-1930 Interesting sex differences may be observed Particularly noticeable is the tendency of the girls to report novels of romance or those dealing with home or school life as their best-liked reading Boys, on the other hand, report, as favorites, novels of adventure and of mystery [6] Both the boys and the girls enjoy detective stories The boys' books fall into the fields of science, biography, history, adventure, and mystery more often than those of the girls The gifted girls read more often than the boys books of fiction and of home and school life The girls read a little more frequently than the boys, and their reading tastes are decidedly more homogeneous

Table 4 gives also the rank assigned by the gifted children to books of different types in 1929-1930 The popularity of the romantic novel for the typical girl is still apparent, the typical boy is now interested in books of adventure, romance, science, and biography. Both sexes now are interested in essays.

The books listed in Tables 5-9 give a fairly accurate picture of the reading interests of gifted children. Titles range from the poorest to the best. Zane Grey, Haliburton, and Wright are read by a con-

[6]In general, these sex differences are like those which Jordan found for mentally average children. See Jordan (10, pp 290-292).

TABLE 5

TEN MOST POPULAR BOOKS REPORTED BY GIFTED BOYS (1924-1925)

Name of book	Author
Huckleberry Finn	Clemens
Treasure Island	Stevenson
Twenty-Thousand Leagues Under the Sea and Other Stories	Verne
Mystery Stories	Poe
Americanization of Edward Bok	Bok
Life of David Crockett	Crockett
Autobiography	Franklin
The Pathfinder	Cooper
Roughing It	Roosevelt
All about Electricity	Knox

TABLE 6

TEN MOST POPULAR BOOKS REPORTED BY GIFTED BOYS (1929)

Name of book	Author
Ivanhoe	Scott
Royal Road to Romance	Haliburton
The Glorious Adventure	Haliburton
Where the Blue Begins	Morley
Mystery Novels	Various authors
The Story of Philosophy	Durant
Revolt in the Desert	Lawrence
Story of a Bad Boy	Aldrich
Sentimental Tommy	Barrie
Sorrell and Son	Deeping

siderable number.[6] The reading as a whole, however, appears decidedly superior in type. Tables 5-8 present the ten best-liked books reported by the children in 1924-1925 and in 1929-1930. The titles alone do not reveal the versatility of interest which characterizes the gifted For example, three children reported *Ethan Frome* as a favorite, others, *A Lost Lady, Buddenbrooks,* and *Jean Christophe* Among biography and autobiography are *We* and *The Glorious Adventure* (the last title is perhaps incorrectly classified) And yet the children reported *That Man Heine, Villon,* and *Napoleon* An unusual feature was the large number of mystery stories mentioned one time only

[6]These books are cited by some teachers and critics as inferior in quality Many may doubt the validity of these citations The writers, however, believe them to be valid.

TABLE 7
TEN MOST POPULAR BOOKS REPORTED BY GIFTED GIRLS (1924-1925)

Name of book	Author
Little Women	Alcott
Hans Brinker	Dodge
The Prince and the Pauper	Clemens
Treasure Island	Stevenson
Jungle Book	Kipling
Vanity Fair	Thackeray
Seventeen	Tarkington
Home Book of Verse	Stevenson
Poems	Tennyson
Jeremy	Walpole

TABLE 8
TEN MOST POPULAR BOOKS REPORTED BY GIFTED GIRLS (1929)

Name of book	Author
The Green Bay Tree	Bromfield
Poetry	Millay
The Crisis	Churchill
Royal Road to Romance	Haliburton
The Scarlet Letter	Hawthorne
One Increasing Purpose	Hutchinson
Color	Cullen
"We"	Lindbergh
Sorrell and Son	Deeping
Glorious Apollo	Barrington

TABLE 9
TEN BEST-LIKED MAGAZINES (1929)

Boys	Girls
American	*American*
Popular Mechanics	*Good Housekeeping*
Liberty	*Cosmopolitan*
Literary Digest	*Saturday Evening Post*
National Geographic	*Ladies Home Journal*
Saturday Evening Post	*Golden Book*
American Boy	*Literary Digest*
Collier's	*National Geographic*
Time	*Time*
American Mercury	*Youth's Companion*

The magazine reading is of special interest and significance. The favorite magazines vary greatly in quality, and they probably reflect the particular opportunities of the children. It is difficult and hazardous to generalize from data such as these. Undoubtedly, the magazine reading depends to a large degree upon the reading material *provided in the home*. Nevertheless, the *choice* of magazines is fairly desirable, and discloses again the versatility of the children's reading interests.

The *fiction reading is undoubtedly* a product also of special impetus and motivation provided by the home and the school. All of the reading must be evaluated with the fact clearly in mind that the children come, in most instances, from superior homes, wherein reading materials are likely to be abundant and somewhat superior in quality

Within recent years a number of significant studies have been made of children's interests in reading (3, 8, 9, 12, 13). The school can help greatly to raise the children's standards of enjoyment by providing them with opportunity to read *the best* of those books and magazines which they like. The data in this paper indicate the books which gifted children within certain CA limits prefer to read These data may be regarded, therefore, as supplementary to the studies of children's reading interests that have been published previously The limited number of individuals included in this study is probably more than offset by the fact that these gifted children have read extensively

Psychologists have urged repeatedly that the gifted child's curriculum be enriched The preferred voluntary reading of the gifted child points the way to an enrichment and one that will not dull his interest in reading.

REFERENCES

1. BURKS, B. S., JENSEN, D W., & TERMAN, L. M Genetic studies of genius Vol III The promise of youth Stanford University, Calif Stanford Univ Press, 1930 Pp xiv+508
2 COY, G L The daily programs of thirty gifted children. *J Genet Psychol.*, 1930, **37**, 123-137
3 CROW, C S Evaluation of English literature in the high school *Teach Coll Contrib Educ*, 1924, No 141 Pp vi+172.
4. FREEMAN, F N The treatment of the gifted child in the light of scientific evidence *Elem. School J*, 1924, **24**, 652 661.
5 GATES, A I The nature and educational significance of physical status and of mental, physiological, social, and emotional maturity. *J Educ Psychol*, 1924, **15**, 329-339.

6 HOLLINGWORTH, L S. Gifted children their nature and nurture New York Macmillan, 1926. Pp. xxiv+374

7. ———— The child of very superior intelligence as a special problem in social adjustment. *Ment. Hygiene,* 1931, 15, 3-16.

8 HUBER, M B, BRUNER, H B., & CURRY, C M Children's interests in poetry. Chicago & New York Rand McNally, 1927 Pp. 3+233

9 JORDAN, A M Children's interests in reading Chapel Hill, N. Car. Univ N. Car. Press, 1926 Pp iii+103.

10. ———— Educational psychology. New York Holt, 1928 Pp xiv+459.

11 TERMAN, L. M Genetic studies of genius Vol I. Mental and physical traits of a thousand gifted children Stanford University, Calif Stanford Univ. Press, 1925. Pp. xv+648.

12. TERMAN, L M., & LIMA, M Children's reading New York; Appleton, 1926. Pp xi+363

13. WASHBURNE, C. S, & VOGEL, M. Winnetka graded book list. Chicago. Amer. Library Asso, 1926. Pp 286.

14 WITTY, P. A A study of one hundred gifted children. *Univ. Kan. Bull Educ,* 1930, 2, No. 7.

15. WITTY, P A., & LEHMAN, H C. A study of vocational attitudes and intelligence *Elem School J.,* 1931, 31, 735-746.

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UNE ÉTUDE DE LA LECTURE ET DES INTÉRÊTS DE LECTURE DES ENFANTS BIEN DOUÉS

(Résumé)

Cet article donne des renseignements détaillés sur la lecture et les intérêts de lecture de 50 enfants bien doués (Q.I. 140 plus). On présente les données de quelques recherches faites en 1924 et en 1929 Les sources des données sont, (1) Les réponses des enfants, (2) les notations et les évaluations du maître, (3) les rapports des parents. La présentation inclut des rapports sur, (1) Le temps consacré à la lecture, (2) Les types de morceaux qui ont plu le plus aux enfants, (3) Les noms des livres et des revues lus le plus frequemment par les garçons et par les filles. On résume brievement l'état mental, les histoires de l'enseignement, l'état physique, et les traits sociaux du groupe. D'ailleurs, on donne des données comparables de tous les détails pour une groupe d'intelligence moyenne (Q.I. 90-110) On peut considerer ces données supplémentaires à celles publiées antérieurement sur la lecture des enfants bien doués Le petit nombre d'enfants compris dans cette étude en est peut-être une limitation importante Cependant, les enfants ont beaucoup lu, et les données sont présentées en détail

WITTY ET LEHMAN

EINE UNTERSUCHUNG DES LESENS UND DER LESEINTERESSEN BEGABTER KINDER

(Referat)

Diese Abhandlung enthalt ausfuhrliche Angaben uber das Lesen und die Leseinteressen von 50 begabten Kindern (Intelligenzquotient uber 140) Es werden Angaben gemacht aus Untersuchungen die in 1924 und 1929 durchgefuhrt worden sind Die Quellen der Angaben sind folgende (1) die Aussagen (responses) der Kinder, (2) die Notierungen und Abschatzungen der Lehrer [uber die Kinder], (3) die Berichterstattungen der Eltern. Die Abhandlung berichtet unter Anderem uber (1) die gesammte Zeit die dem Lesen gewidmet wird, (2) die Art der Lekture die am meisten gefallt, (3) die Namen der Bucher und Zeitschriften die von Madchen und von Knaben am meisten gelesen werden. Die geistige Beschaffenheit (mental constitution), die pedagogischen Anamnesen (educational histories), der korperliche Zustand, und die sozialen Eigenschaften der Gruppe werden kurz zusammengefasst Ferner werden vergleichbare Angaben in Bezug auf alle diese Gegenstande uber eine geistig mittelmassige (average) Gruppe dargeboten (Intelligenzquotient 90 bis 110) Diese Angaben durfen als Tatsachen angesehen werden die die vorher uber die Lektüre begabter Kinder gesammelten erganzen Die Kleinheit der Zahl der in dieser Untersuchung berucksichtigten Kinder stellt vielleicht einen deutlichen Mangel der Untersuchung dar. Die Kinder haben aber weitlaufig gelesen und die Angaben werden ausfuhrlich dargestellt.

WITTY UND LEHMAN

SHORT ARTICLES AND NOTES

A SCHEME FOR GRADING THE REACTIONS OF CHILDREN IN A NEW SOCIAL SITUATION—ERRATUM

RUTH W. WASHBURN

On page 93 of this volume Parts A and B of Chart 1 have been transposed Read legend A with the graph labeled B, and vice versa

THE STANFORD REVISION OF THE BINET-SIMON TESTS COMPARED WITH THE PINTNER-PATERSON SHORT PERFORMANCE SCALE[1]

HENRY FEINBERG

The purpose of this paper is to present the results of a study comparing what Professor Rudolf Pintner calls "concrete intelligence" as determined by the Pintner-Paterson Short Performance Scale with general intelligence as determined by the Stanford Revision of the Binet-Simon Tests The study comprises 807 cases seen since September, 1926, at the Mental Hygiene Clinic,[2] a unit of the Jewish Social Service Bureau of Detroit and an out-

[1]May we express our appreciation to Professor Rudolf Pintner and to Dr Harry E August for their valuable suggestions

[2]The Mental Hygiene Clinic, associated with the Jewish Social Service Bureau of Detroit, is a creation of Mrs R. M Lipson, Director of the Bureau, who, with her accustomed foresight, saw the importance of the association of such a clinic with a family case work agency. With the aid of Dr. Nellie Perkins, then of the Juvenile Court Clinic, and of Dr Theophile Raphael, then of the State Psychopathic Hospital, University of Michigan, the Clinic started its operations in the fall of 1923 In the spring of 1924 the Clinic was accepted by the Board of Trustees of the University Hospital as an out-patient clinic

patient clinic of the State Psychopathic Hospital of the University of Michigan

As far as possible, all cases coming to the Clinic for psychological examination who were chronologically five years or more were given, among others, two tests, the Stanford Revision of the Binet-Simon Tests and the Pintner-Paterson Short Performance Scale Of those receiving both examinations within the same month, the writer recorded the gross age results of the performance on the Stanford Revision of the Binet-Simon Tests (i e,

TABLE 1
Distribution of Increment

	Female children	Male children	Children (total)	Female adults	Male adults	Adults (total)	Total
Childrens' Aid Society—local and state offices	49	47	96	14	0	14	110
Department of Public Welfare	13	11	24	10	5	15	39
Detroit Hebrew Orphan Home	11	16	27	0	1	1	28
Detroit Public Schools	4	4	8	0	0	0	8
Detroit Public Schools—Department of Attendance	3	10	13	0	2	2	15
Detroit Public Schools—Psychological Clinic	1	5	6	0	0	0	6
Florence Crittenton Hospital	0	0	0	1	0	1	1
Fresh Air Society	1	0	1	0	0	0	1
Girls' Protective League	0	0	0	1	0	1	1
Jewish Child Care Council	17	19	36	2	0	2	38
Jewish Social Service Bureau—Boy's Dept	1	66	67	0	34	34	101
Jewish Social Service Bureau—Childrens' Bureau	16	20	36	0	0	0	36
Jewish Social Service Bureau—Family Welfare	62	68	130	22	18	40	170
Jewish Social Service Bureau—Girls' Department	13	0	13	18	0	18	31
Juvenile Court	1	0	1	1	0	1	2
North End Clinic	38	58	96	50	20	70	166
Personal	9	24	33	2	3	5	38
Private sources	3	7	10	1	5	6	16
Total	242	355	597	122	88	210	807

mental ages of 8 years to 8 years 11 months, inclusive, were recorded as 8 years), *and the median mental age the patient attained on the Pintner-*Paterson Short Performance Scale, the patient's chronological age, sex, and the diagnosis he received according to Terman's classification. Thus, any case which received an IQ on the Stanford Revision of the Binet-Simon Tests of 70.4 and below would be classified as feebleminded, 70.5 to 80.4 as borderline, 80.5 to 90.4 as dull normal, 90.5 to 110.4 as normal, 110.5 and above as superior. For correlation purposes, D.N.C. on the Pintner-Paterson Short Performance Scale was evaluated as 3.

Testing conditions were quite similar throughout. All of the tests were given by the writer. Of the battery of tests the patient received, the first two given him were the Stanford Revision of the Binet-Simon Tests and the Pintner-Paterson Short Performance Scale. In 98% of the cases, these tests were given the patient between 9 and 11 in the morning. As far as possible every effort was made to examine the patients under the most propitious circumstances. *Precautions were taken to rule out illness and* emotional disturbances and to establish a favorable degree of rapport before testing was begun. Privacy was insured.

Description

Of the 807 cases herein reported, 597 were children, 210, adults, 364, females, 443, males; 242, female children; 355, male children, 122, female adults, and 88 were male adults. Adults had attained the age of 16. Since the inception of the Clinic many of Detroit's social agencies have made use of its facilities. Table 1 shows the classification of cases as to age and sex, also the social agencies from which they were referred.

Cases included in this series were referred for a whole gamut of conditions which ordinarily come within the purview of the child guidance clinic, psychological clinic, vocational guidance clinic, and the out-patient *psychiatric clinic. Cases were referred for everything from psychometric* tests to institutionalization. The largest number of cases were seen because of social maladjustment which took the form of more or less serious delinquency.

TABLE 2
DISTRIBUTION OF IQ'S

	No	Mean IQ	Range
All Cases	807	89.44	30.5-157.3
Children	597	92.78	40.6-157.3
Female children	242	92.35	48.5-129.8
Male children	355	93.08	40.6-157.3
Adults	210	79.93	30.5-121.8
Female adults	122	76.90	36.4-118.7
Male adults	88	84.15	30.5-121.8
Females	364	87.18	36.4-129.8
Males	443	91.30	30.5-157.3

A description of the intelligence range of the cases may be represented by an analysis of the IQ's they attained on the Stanford Revision of the Binet-Simon Tests (see Table 2)

The curve of distribution is skewed somewhat to the left. The IQ, on the average, was generally higher for the males than for the females, and for the children than for the adults.

The tests used were given to the patients in accordance with the methods prescribed by their respective authors. [For description of the Stanford Revision of the Binet-Simon Tests, see Terman (3, pp. 121 ff)] The tests used in giving the Pintner-Paterson Short Performance Scale were The Mare and Foal, the Seguin Form Board, the Five Figure Form Board, the Two Figure Form Board, the Casuist Form Board, the Mannikin, the Feature Profile, the Ship Test, the Picture Completion, and the Cube Test [For detailed description see Pintner and Paterson (2, pp. 25-69)]

Correlations

General Correlations. The general correlation between the two tests will be seen in Table 3.

Correlation—Children with Adults The correlation of the various groups of children and adults is indicated in Table 4 It is rather obvious from this table that children's scores on the two tests correlate better than do those of adults. This is partly due to the limitations in the ranges of the two tests It must be remembered that the highest possible median mental age on the Pintner-Paterson is 15.

Correlation—Males and Females. The correlation of the performance between males and females is indicated in Table 5. By and large, there seems to be little difference between the performances of the males and females The feebleminded males seem to correlate better than the feebleminded females, while the borderline females and dull females correlate better than the males

Correlation by Diagnoses Correlations with individuals grouped according to Terman's classification are compared in Table 6. In the first section, the childrens' section, the male and the female sections indicate a tendency for the correlation to rise with the ascendency of the IQ. That this tendency is not completely borne out is probably due to the limitations in the range of the tests as well as to the small number of cases represented in each group.

Comparison on Basis of Chronological Age Levels. The median mental age as well as the mean age was taken into consideration with the results evidenced in Table 7 It is interesting to note the fairly good consistency in the MA's throughout There seems to be, on the whole, a good agreement between the MA's on the two tests for most groups

TABLE 3

GENERAL CORRELATIONS

	No	*r*	*P.E*	Standard deviation Binet	Standard deviation Pintner	Mean age Binet	Mean age Pintner	Median age Binet	Median age Pintner
All Cases	807	785	009	3 447	3 168	10 399	9 938	10	10
Children	597	785	009	3 133	3 121	9 695	9.452	9	9
Female children	242	.782	017	2.989	3.071	9.707	9 471	9	9
Male children	355	787	013	2 215	3 156	9 687	9 439	9	9
Adults	210	735	021	3 532	2 875	12 400	11 319	12	12
Female adults	122	755	027	3 600	2 985	11 934	11 171	12	12
Male adults	88	694	037	3 330	2 701	13 034	11 523	13	12
Females	364	.785	013	3 375	3 147	10 453	10 041	10	10
Males	443	785	012	3 504	3.181	10 354	9.853	10	10

TABLE 4

CORRELATION—CHILDREN AND ADULTS

	No	r	PE	Standard deviation Binet	Standard deviation Pintner	Mean age Binet	Mean age Pintner	Median age Binet	Median age Pintner
Children	597	.785	009	3 133	3 121	9 695	9 452	9	9
Adults	210	735	021	3 532	2 875	12 400	11.319	12	12
Female children	242	.782	017	2 989	3 071	9 707	9 471	9	9
Female adults	122	755	027	3 600	2.985	11 934	11 171	12	12
Male children	355	787	013	2.215	3.156	9 687	9 439	9	9
Male adults	38	694	037	3 330	2 701	13 034	11 523	13	12
Feebleminded children	66	701	042	1.933	3 105	7.530	8 484	8	9
Feebleminded adults	72	.560	054	1.598	2 585	8 444	8 611	9	8 5
Feebleminded female children	30	581	072	1 707	3 165	7 300	8 570	8	9
Feebleminded female adults	51	575	041	1.508	2 659	8 373	8 706	9	9
Feebleminded male children	36	804	040	2 109	3 060	7.584	8 472	8	9
Feebleminded male adults	21	658	080	1 785	2 392	8 619	8 381	9	8
Borderline children	66	735	038	2 073	2 878	9 091	9 470	9	10
Borderline adults	31	059	.119	551	2.070	11 613	11.677	12	12
Borderline female children	28	.780	052	2 059	2 776	8 893	9 286	9	9
Borderline female adults	14	000	181	463	2 220	11 714	11 714	12	12
Borderline male children	38	.697	055	2 069	2 942	9 237	9 605	10	10
Borderline male adults	17	111	161	604	1 939	11 529	11 647	12	12

TABLE 4 (*continued*)

	No	r	P.E	Standard deviation Binet	Standard deviation Pintner	Mean age Binet	Mean age Pintner	Median age Binet	Median age Pintner
Dull children	112	.733	025	2 449	3.059	9 017	9 098	9	9
Dull adults	32	220	.114	.545	1 405	13 125	12.688	13	13
Dull female children	41	.786	040	2 516	2 705	8 755	8.537	8	8
Dull female adults	20	154	.147	381	1 030	13 050	12 800	13	13
Dull male children	71	691	042	2 393	3 192	9 169	9.423	9	9
Dull male adults	12	356	168	719	1 842	12 418	12 378	13	13
Normal children	264	847	011	3 159	3 101	9 936	9 583	10	9
Normal adults	58	.288	.084	1 066	1 713	15 603	13.131	15 5	14
Normal female children	109	811	.022	3 023	3 067	10 339	9 817	10	10
Normal female adults	29	247	.121	1 005	1 404	15.759	13 448	16	14
Normal male children	155	870	013	3 220	3 113	9 652	9 419	9	9
Normal male adults	29	256	114	1 102	1 919	15 483	12 793	15	14
Superior children	89	859	.019	3.603	3.217	11 910	10 190	12	10
Superior female children	17	245	.229	473	1 376	18 294	13 470	18	14
Superior adults	34	877	027	3 174	3 131	12 500	10 353	11 5	10
Superior female adults	8	020	228	487	1 318	18 375	13 625	18	14
Superior male children	55	866	022	3 822	3 260	12 164	10 072	12	10 5
Superior male adults	9	426	181	422	1 414	18 222	13 333	18	14

TABLE 5

CORRELATION—MALES AND FEMALES

	No	r	P E	Standard deviation Binet	Standard deviation Pintner	Mean age Binet	Mean age Pintner	Median age Binet	Median age Pintner
Females	364	785	013	3.375	3 147	10 354	10 041	10	10
Males	443	785	012	3 504	3 181	10 354	9 853	10	10
Female children	242	.782	017	2 989	3 071	9 707	9 471	9	9
Male children	355	787	013	2 215	3 156	9 687	9 439	9	9
Female adults	122	755	027	3 600	2.985	11 934	11 171	12	12
Male adults	88	694	.037	3.330	2 701	13 034	11 523	13	12
Feebleminded females	81	.567	.050	1.640	2.960	8.050	8 655	8	9
Feebleminded males	57	.730	042	2 055	2 821	7 947	8 404	8	8
Feebleminded female children	30	581	072	1 707	3 165	7 500	8 570	8	9
Feebleminded male children	36	804	.040	2 109	3 060	7 584	8 472	8	9
Feebleminded female adults	51	575	041	1 508	2 659	8 737	8 706	9	9
Feebleminded male adults	21	.658	.080	1 785	2 392	8 619	8 381	9	8
Borderline females	42	731	048	2 159	2.844	9 833	10 095	11	11
Borderline males	55	685	048	2 048	2 833	9.945	10 236	11	10
Borderline female children	28	780	.052	2 059	2.776	8 893	9 286	9	9
Borderline male children	38	697	.055	2 069	2 942	9.237	9.605	10	10
Borderline female adults	14	000	181	.463	2 220	11 714	11 714	12	12
Borderline male adults	17	111	.161	604	1 939	11.529	11 647	12	12

TABLE 5 (*continued*)

	No	r	P.E	Standard deviation Binet	Standard deviation Pintner	Mean age Binet	Mean age Pintner	Median age Binet	Median age Pintner
Dull females	61	867	021	2 893	3.040	10 164	9 934	11	11
Dull males	83	722	052	2 655	3 193	9 755	9 855	10	10
Dull female children	41	786	040	2 516	2 705	8 755	8 537	8	8
Dull male children	71	.691	.042	2 393	3 192	9 169	9 423	9	9
Dull female adults	20	154	147	381	1.030	13 050	12 800	13	13
Dull male adults	12	356	168	7 19	1 842	12.418	12 378	13	13
Normal females	138	835	017	3 508	3 169	11 478	10 580	12	11
Normal males	184	856	013	3 659	3.202	10 565	9 951	10	10
Normal female children	109	811	022	3.023	3 067	10 339	9 817	10	10
Normal male children	155	870	013	3 220	3 113	9 652	9 419	9	9
Normal adult females	29	247	121	1.005	1 404	15 759	13 448	16	14
Normal adult males	29	256	114	1.102	1 919	15 483	12 793	15	14
Superior females	42	848	029	3 923	3 154	12 810	12 000	12	12
Superior males	64	867	.021	4.125	3 276	13 016	10 531	13	12
Superior female children	34	.877	027	3 174	3 131	12 500	10.353	11 5	10
Superior male children	55	866	022	3 822	3 260	12 164	10 072	12	10 5
Superior female adults	8	020	228	.487	1 318	18 375	13.625	18	14
Superior male adults	9	426	181	422	1 414	18 222	13 333	18	14

TABLE 6

CORRELATION BY DIAGNOSES

	No	r	P.E	Standard deviation Binet	Standard deviation Pintner	Mean age Binet	Mean age Pintner	Median age Binet	Median age Pintner
Feebleminded	138	618	.036	1 825	2 847	8 007	8.553	8	9
Borderline	97	707	035	2 098	2.839	9 897	10 175	11	11
Dull normal	144	782	021	2 764	3 147	9 931	9 889	10	10 5
Normal	322	849	011	3 623	3 203	10 957	10 224	11	10
Superior	106	857	017	4 087	3 229	12 943	10 717	12 5	12
Feebleminded children	66	701	.042	1 933	3 105	7 530	8 484	8	9
Borderline children	66	735	038	2.073	2 878	9 091	9 470	9	10
Dull children	112	733	025	2 449	3 059	9 017	9 098	9	9
Normal children	264	847	011	3 159	3 101	9 936	9 583	10	9
Superior children	89	859	019	3 603	3 217	11 910	10 190	12	10
Feebleminded female children	30	581	072	1 707	3 165	7 500	8 570	8	9
Borderline female children	28	780	052	2 059	2 776	8 893	9 286	9	9
Dull female children	41	786	040	2 516	2 705	8 755	8 537	8	8
Normal female children	109	811	022	3 023	3.067	10 339	9 817	10	10
Superior female children	54	877	027	3 174	3 131	12 500	10.353	11 5	10
Feebleminded male children	36	804	040	2 109	3 060	7 584	8 472	8	9
Borderline male children	38	697	055	2 069	2 942	9 237	9 605	10	10
Dull male children	71	691	042	2 393	3 192	9 169	9 423	9	9
Normal male children	155	870	013	3 220	3 113	9 652	9 419	9	9
Superior male children	55	866	022	3 822	3 260	12 164	10 072	12	10 5
Feebleminded adults	72	560	054	1 598	2 585	8 444	8 611	9	8 5
Borderline adults	51	059	119	551	2 070	11 613	11 677	12	12
Dull adults	32	220	114	.545	1 405	13 125	12 688	13	13
Normal adults	58	288	084	1 066	1 713	15 603	13 131	15 5	14
Superior adults	17	245	229	473	1 376	18 294	13 470	18	14

TABLE 6 (*continued*)

	No	r		Standard deviation Binet	Pintner	Mean age Binet	Pintner	Median age Binet	Pintner
Feebleminded female adults	51	.575	041	1.508	2 659	8 373	8 706	9	9
Borderline female adults	14	000	.181	463	2 220	11 714	11 714	12	12
Dull female adults	20	154	.147	.381	1 030	13.050	12 800	13	13
Normal female adults	29	247	121	1 005	1 404	15 759	13 448	16	14
Superior female adults	8	.020	228	.487	1 318	18 375	13 625	18	14
Feebleminded male adults	21	.658	.080	1 785	2 392	8 619	8 381	9	8
Borderline male adults	17	111	161	.604	1 939	11 529	11 647	12	12
Dull male adults	12	356	.168	719	1 842	12 418	12 378	13	13
Normal male adults	29	.256	.114	1 102	1.919	15.483	12 793	15	14
Superior male adults	9	426	.181	.422	1 414	18 222	13 333	18	14
Feebleminded females	81	567	050	1 640	2 960	8 050	8 655	8	9
Borderline females	42	731	048	2 159	2 844	9 833	10 095	11	11
Dull females	61	867	.021	2 893	3.040	10 164	9 934	11	11
Normal females	138	835	017	3 508	3 169	11 478	10 580	12	11
Superior females	42	.848	.029	3 923	3 154	12.810	12 000	12	12
Feebleminded males	57	730	042	2 055	2 821	7 947	8 404	8	8
Borderline males	55	685	048	2 048	2 833	9 945	10 236	11	10
Dull males	83	.722	052	2 655	3 193	9.755	9 855	10	10
Normal males	184	856	013	3 659	3.202	10 565	9 651	10	10
Superior males	64	867	.021	4 125	3.276	13 016	10 531	13	12

TABLE 7

COMPARISON AT CHRONOLOGICAL AGE LEVELS

CA			Total Number	Median age Binet	Median age Pintner	Mean age Binet	Mean age Pintner	Standard deviation Binet	Standard deviation Pintner
5			31	5	5	5 16	4 81	573	1 029
	Females	8		5	5	5 25	5.00	433	866
	Males	23		5	5	5 13	4 74	1 044	1 072
6			37	6	5	5 81	5 49	1 061	1 149
	Females	14		5	5	5 64	5 14	1 445	1.381
	Males	23		6	6	5 91	5 70	717	952
7			44	7	7	6 77	6 52	1 084	1.661
	Females	17		7	6	6 94	6 47	802	1 575
	Males	27		7	7	6 67	6.56	1 217	1 810
8			59	8	7	7.58	7 44	1 268	1 679
	Females	27		8	7	7 48	7.44	1.259	2 022
	Males	32		7	7	7 66	7 44	1 265	1 321
9			67	9	9	8 91	8 84	1 681	1 923
	Females	30		9	9	8 97	8 90	1 402	1 009
	Males	37		8	9	8 86	8 78	2.109	2 344
10			50	10	9 5	9 86	9 52	1 789	2.427
	Females	18		10 5	9 5	10 12	9.50	1 729	2 619
	Males	32		10	9 5	9 75	9 53	1 790	2 368
11			49	9	9	9 43	9 67	2 040	2 333
	Females	20		9	9	9 55	9 40	2 083	2 004
	Males	29		9	9	9.34	9 86	2 004	2 609

TABLE 7 (*continued*)

CA		Total Number	Median age Binet	Median age Pintner	Mean age Binet	Mean age Pintner	Standard deviation Binet	Standard deviation Pintner
12		62	11	12	10.69	10.98	2.279	2.581
Females	33		11	12	10.76	11.03	2.412	2.725
Males	29		10	11	10.62	10.93	2.156	2.405
13		60	12	12	11.65	11.58	2.489	2.204
Females	25		11	12	10.84	11.20	2.161	2.047
Males	35		13	12	12.23	11.86	2.542	2.080
14		60	13	12	12.48	11.90	2.675	2.301
Females	21		12	12	12.10	11.48	2.174	2.630
Males	39		13	12	12.69	12.13	2.774	1.857
15		78	12.5	12.5	12.85	11.97	2.474	2.555
Females	29		14	13	13.34	12.38	2.563	2.124
Males	49		12	12	12.63	11.80	2.577	2.465
All children		597	9	9	9.70	9.45	3.133	3.121
Females	242		9	9	9.70	9.47	2.989	3.071
Males	355		9	9	9.69	9.39	3.215	3.156
All adults		210	12	12	12.40	11.32	3.532	2.875
Females	122		12	12	11.93	11.19	3.600	2.985
Males	88		13	12	13.03	11.52	3.330	2.701
All cases		807	10	10	10.40	9.94	3.447	3.168
Females	364		10	10	10.45	10.04	3.375	3.147
Males	443		10	10	10.35	9.85	3.504	3.181

Summary

1. The correlation of these two tests is not as high for adults as it is for children.

2. There does not seem to be much difference between the sexes in their performances on the tests

3. There is a tendency for the correlation to rise with the ascendency of the intelligence quotient

4. There seems to be a fairly good agreement, by and large, between the mental ages with the exception of the adult and superior groups. This exception is probably due to the fact that the Pintner-Paterson Short Performance Scale does not attain a sufficiently high mental age

5. The present study suggests the possibilities of a similar study comparing the Binet with other performance scales.

References

1. Feinberg, H., & August, H. E. The Mental Hygiene Clinic in Detroit. *Jewish Soc Serv Quar*, 1927, **3**, 44-52

2. Pintner, R., & Paterson, D. G. A scale of performance tests. New York Appleton, 1917 Pp. x+218

3. Terman, L. M. The measurement of intelligence. Boston Houghton Mifflin, 1916 Pp 362

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NOTE ON THE RELATION OF SIMPLE TO SERIAL REACTION

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The literature which pertains to simple reaction and serial reaction reveals that these two tasks are specific motor skills, that is, little or no relationship exists between them (2, 4, 5, 8, 9)[1] However, in virtually all measurements of simple reaction a preparatory stimulus has been given in order to "set" the subject for the response In serial reaction, on the other hand, the performance is of a more random nature in which the subject is totally unaware of the next movement which he will execute. Hence, part of the specificity of simple and serial reaction might be attributed to differences in the motor attitudes of subjects during the two performances

Cattell (3) and Woodrow (12) have shown that readiness for response tends to reduce the time required for simple reaction, but the amount of the reduction is not constant from individual to individual Apparently, then, simple performance with a preparatory stimulus is to some extent different from simple performance which is executed without a preparatory stimulus.[2] In the present paper an attempt is made to determine (a) the

[1]A summary of this literature has been prepared for publication elsewhere Cf (1)

[2]General reviews of the literature on reaction-times are given in (6, 7, 11)

influence of preparedness and unpreparedness on simple reaction-time, and (*b*) the contribution of preparedness to the lack of relationship between simple reaction and serial reaction

For the measurement of serial reaction, the Seashore serial discrimeter was used. This apparatus calls for the successive activation of the four fingers of the right hand in response to four numbers which are presented visually in a random succession. A Dunlap chronoscope was employed for recording the simple reaction-times Every subject was instructed to press a telegraph key with his right hand when he observed any movement of the pointer on the dial of the chronoscope In one series a preparatory stimulus, "ready," was given from 1½-3 seconds prior to the engaging of the recording mechanism of the chronoscope. In a second series no preparatory stimulus was given, and the instrument was engaged at varying intervals of 3-20 seconds after the previous reaction.

The testing program was divided into two parts, each of which included 40 prepared simple reactions, 40 unprepared simple reactions, and 4 two-minute trials on the discrimeter. The order of administration was altered from subject to subject in order to hold constant the trial-position error in each test. Thirty-eight men who are students in Brown University served in this study.

The means, the standard deviations, and the reliability coefficients, which have been corrected with the Brown-Spearman formula, are as follows:

	Mean	*SD*	r_{II}
Simple reaction, prepared	174 6	21 5	0 88
Simple reaction, unprepared	208.3	21 5	0.88
Serial reaction	196	35.2	0 98

Simple reaction is expressed in thousandths of seconds, while the score for serial reaction is the number of correct discriminative finger movements made in a two-minute period.

Correlations among the three measures and the percentage of common factors represented by each coefficient are as follows

	r	% commonality
Simple reaction, prepared-simple reaction, unprepared	0 65	55
Simple reaction, prepared-serial reaction	0 36	23
Simple reaction, unprepared-serial reaction	0 33	20

In each case the obtained *r* was corrected for attenuation and squared This technique gives an indication of the percentage of common factors which exists in the respective tests (10)

The differences between the means of the two types of simple reaction show that a longer time is required for response without than with a preparatory stimulus. But that there are individual fluctuations with respect to the group between the two kinds of reaction is disclosed by the $r=0.65$ This fact checks with the observations of Cattell and Woodrow Incidentally, one recalls here, in addition, the reputed importance of *Einstellungen, Aufgaben,* and *Bewusstseinlagen* which was so firmly emphasized after Cattell's study

The standard deviation of the scores in serial reaction is about one-third greater than similar sigmas reported elsewhere in the literature (2). Also, the correlation between serial reaction and prepared simple reaction is somewhat higher than that of previous results. The latter discrepancy rests in part upon the excessive range of the serial reaction scores.

*Finally, the two kinds of simple reaction, both of which between them*selves contain many dissimilar factors, correlate about equally with serial reaction Hence, it follows that the presence or absence of a preparatory stimulus in simple reaction has little or no effect upon the degree of specificity which maintains between simple and serial reaction

REFERENCES

1 BECK, L F. The role of speed in intelligence *Psychol Bull.*, 1932, **29**, (in press)

2 ——— Relation of speed of reaction to intelligence *Amer J. Psychol*, 1932, **44**, (in press)

3. CATTELL, J McK Psychometrische Untersuchungen *Phil Stud*, 1888, **3**, 305-336.

4 FARNSWORTH, P R, SEASHORE, R H, & TINKER, M. A Speed in simple and serial reaction as related to performance in certain "intelligence tests" *J Genet Psychol.*, 1927, **34**, 537-551.

5 HANSEN, C. F Serial action as a basic measure of motor capacity. *Psychol. Monog*, 1922, **31**, 320-382

6 HENMON, V A C. Reaction time *Psychol. Bull*, 1910, **7**, 375-377, 1912, **9**, 232-235; 1913, **10**, 451-453, 1914, **11**, 409-412; 1915, **12**, 414-415, 1916, **13**, 427-428, 1917, **14**, 411-412; 1918, **15**, 344-345, 1919, **16**, 293-294, 1920, **17**, 330

7 JOHNSON, H M General review, reaction time experiments. *Psychol. Bull*, 1923, **20**, 562-587

8 PERRIN, F A C An experimental study of motor ability *J Exper. Psychol*, 1921, **4**, 24-57.

9 SEASHORE, R H Individual differences in motor skills *J. Gen. Psychol*, 1930, **3**, 38-66.

10 TRYON, R. C The interpretation of the correlation coefficient *Psychol Rev*, 1929, **36**, 419-445

11 WOODROW, H. Reaction times *Psychol Bull*, 1911, **8**, 387-390

12. ——— The measurement of attention. *Psychol Monog*, 1914, **17**, No 76 Pp 158

Brown University
Providence, Rhode Island

BOOKS

ALLEN, R D, BUTTERFIELD, W H, & TULLY, M Providence inventory test in music. (Form A) Yonkers, N Y World Book Co, 1932 Pkg of 25, $1 10

BINGHAM, W V [Ed] Psychology today lectures and study manual Chicago Univ Chicago Press, 1932 Pp xii+272+44+32+32+36 $1 50

BLACKSTONE, E G, & McLAUGHLIN, M. W Blackstone stenographic proficiency tests; Stenography test. Yonkers, N Y World Book Co, 1932 Pkg of 25, $1.20

BRIDGES, K M B *The social and emotional development of the pre-school child.* London Kegan Paul, 1931 Pp x+277 12s 6d

BROWN, A E. The effectiveness of large classes at the college level an experimental study involving the size variable and the size-procedure variable *Univ. Iowa Stud · Stud Educ*, 1932, 7, No 3 (New Ser, No 232) *Pp. 66 $75*

Brush Foundation and Western Reserve University Physical and mental adolescent growth *Proc Conf Adolesc*, Cleveland, 1930 Pp 152

BURNHAM, W H The wholesome personality a contribution to mental hygiene New York & London Appleton, 1932 Pp xxvi+713 $2 75.

BURROW, T The structure of insanity. (*Psyche Miniatures, Gen Ser.*, No 40) London Kegan Paul, 1932 Pp 80

CARRÉ, J R La philosophie de Fontenelle ou le sourire de la raison Paris. Alcan, 1932 Pp 701 70 fr

CHASE, L *Motivation of young children an experimental study of the influence* of certain types of external incentives upon the performance of a task *Univ Iowa Stud Stud. Child Welfare*, 1932, 5, No 3 (1st Ser., No 223) Pp. 119 Cloth, $1 35, paper, $1.00

DUNLAP, J W, & KURTZ, A K Handbook of statistical nomographs, tables, *and formulas Yonkers, N Y World Book Co., 1932 Pp x+163*

GAULT, R H Criminology Boston Heath, 1932 Pp. x+461 $3 48

HALL, C, & BALLACHEY, E L A study of the rat's behavior in a field a contribution to method in comparative psychology *Univ Calif Publ Psychol*, 1932, 6, No. 1, 1-12

HISSONG, C The activity movement New York Warwick & York, 1932 Pp x+122 $2 10.

HUMPHREY, G, & HUMPHREY, M. The wild boy of Aveyron, by J Itard New York & London. Century, 1930. Pp xxiv+104 $1.25

JOHNSON, W *The influence of stuttering on the personality Univ Iowa Stud Stud Child Welfare*, 1932 5, No 5 (1st Ser, No 224) Pp 140

KEILHACKER, M Der ideale Lehrer nach der Auffassung der Schuler eine experimentelle Untersuchung Freiburg Herder, 1932 Pp vii+156

KENNEDY-FRASER, D Education of the backward child New York · Appleton, *1932 Pp x+236 $1 80*

KRECHEVSKY, I "Hypotheses" versus "chance" in the pre-solution period in sensory discrimination-learning and the genesis of "hypotheses" in rats *Univ Calif Publ Psychol*, 1932, 6, No. 3, 27-44, No 4, 45-64

KRECHEVSKY, I., & HONZIK, C. H. Fixation in the rat. *Univ. Calif. Publ. Psychol.*, 1926, 6, No. 2, 13-26.

LANDMAN, J. H. Human sterilization. New York: Macmillan, 1932. Pp. xviii+341. $4.00.

LANE, R. H. A teacher's guide book to the activity program. New York: Macmillan, 1932. Pp. viii+257. $2.00.

MACKINTOSH, H. K. A critical study of children's choices in poetry. *Univ. Iowa Stud.: Stud. Educ.*, 1932, 7, No. 4 (New Ser., No. 234). Pp. 128. $1.00.

MORENO, J. J. Plan and technique of developing a prison into a socialized community. New York: National Committee on Prisons and Prison Labor, 1932. Pp. 68.

MURCHISON, C. [Ed.] A history of psychology in autobiography: Vol. 2, by Bourdon, B., Drever, J., Dunlap, K., Ferrari, G. C., Franz, S. I., Groos, K., Heymans, G., Hoffding, H., Judd, C. H., Morgan, C. L., Pillsbury, W. B., Terman, L. M., Washburn, M. F., Woodworth, R. S., & Yerkes, R. M. Worcester, Mass.: Clark Univ. Press; London: Oxford Univ. Press, 1932. Pp. xx+407. $5.00.

PAUL, H. G., & MILLER, W. D. Teaching manual for language goals. Grades 1-4. Chicago & New York: Lyons & Carnahan, 1932. Pp. vi+249.

PETERSON, E. T., LINDQUIST, E. F., JEEP, H. A., & PRICE, M. P. Teacher supply and demand in Iowa. *Univ. Iowa Stud., Stud. Educ.*, 1932, 7, No. 2 (New Ser., No. 229). Pp. 464. $2.50.

PETRAN, L. A. An experimental study of pitch recognition. *Psychol. Monog.*, 1932, 42, No. 6 (Whole No. 193). Pp. 124.

PILLSBURY, W. B. An elementary psychology of the abnormal. New York & London: McGraw-Hill, 1932. Pp. x+375. $2.50.

RUCKMICK, C. A., & TRAVIS, L. E. University of Iowa Studies in Psychology, No. 115. *Psychol. Monog.*, 1932, 43, No. 1 (Whole No. 194). Pp. viii+303.

SEASHORE, C. E. [Ed.] The vibrato. *Univ. Iowa Stud.: Stud. Psychol. Music*, 1932, 1 (New Ser., No. 225). Pp. 382. Paper, $2.00; cloth, $2.50.

SEIBERT, L. C. A series of experiments on the learning of French vocabulary. *Johns Hopkins Univ. Stud. Educ.*, 1932, No. 18. Pp. 106. $1.50.

SMOKE, K. L. An objective study of concept formation. *Psychol. Monog.*, 1932, 42, No. 4 (Whole No. 191). Pp. vi+46.

STETSON, F. L. Studies in secondary education in Oregon. II. Instructional costs in 226 standard high schools. *Univ. Ore. Publ., Educ. Ser.*, 1931, 2, 297-324.

STONE, C. P., DARROW, C. W., LANDIS, C., & HEATH, L. L. Studies in the dynamics of behavior, ed. by K. S. Lashley (*Behav. Res. Fund Monog.*). Chicago: Univ. Chicago Press, 1932. Pp. xiv+332. $5.00.

THOM, D. A. Normal youth and its everyday problems. New York & London: Appleton, 1932. Pp. xvi+368. $2.25.

THORNDIKE, E. L. The fundamentals of learning. New York: Bur. Publ., Teach. Coll., Columbia Univ., 1932. Pp. xviii+638.

TSAI, L. S. The laws of minimum effort and maximum satisfaction in ani-

mal behavior *Monog Nat Res. Instit Psychol, Academia Sinica* (Peiping, China). Pp 48

VAN ALSTYNE, D Play behavior and choice of play materials of pre-school children Chicago Univ. Chicago Press, 1932. Pp. xii+104 $1 50

WALLENROD, R John Dewey, éducateur. Paris Jouve, 1932 Pp 227

WALLIS, R S How children grow an anthropometric study of private school children from two to eight years of age. *Univ. Iowa Stud. Stud. Child Welfare,* 1931, 5, No 1 (New Ser, No 208) Pp 137. Paper, $1 00, cloth, $1 35.

WARDEN, C J The evolution of human behavior. New York. Macmillan, 1932 Pp xii+248 $3 00.

WARING, E B, & WILKER, M The behavior of young children: III Children with materials—children with other children (*Series on childhood education,* ed by P S Hill) New York Scribner's, 1932. Pp xiv+198

WASHBURNE, C Adjusting the school to the child practical first steps Yonkers, N Y World Book Co, 1932 Pp xvi+189 $1 68.

WHEELER, R H., & PERKINS, F T. Principles of mental development a textbook in educational psychology. New York. Crowell, 1932 Pp. xxviii+529 $3 75.

WILCOX, R Private secondary education in the association of colleges and secondary schools of the southern states *Johns Hopkins Univ Stud. Educ,* 1932, No 19 Pp 151 $2 00

WOLFLE, D. L. The relation between linguistic structures and associative interference in artificial linguistic material *Lang. Monog,* 1932, No 11 Pp 54

ZUCKERMAN, S The social life of monkeys and apes. New York Harcourt, Brace, 1932 Pp xii+356 $3.75.

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